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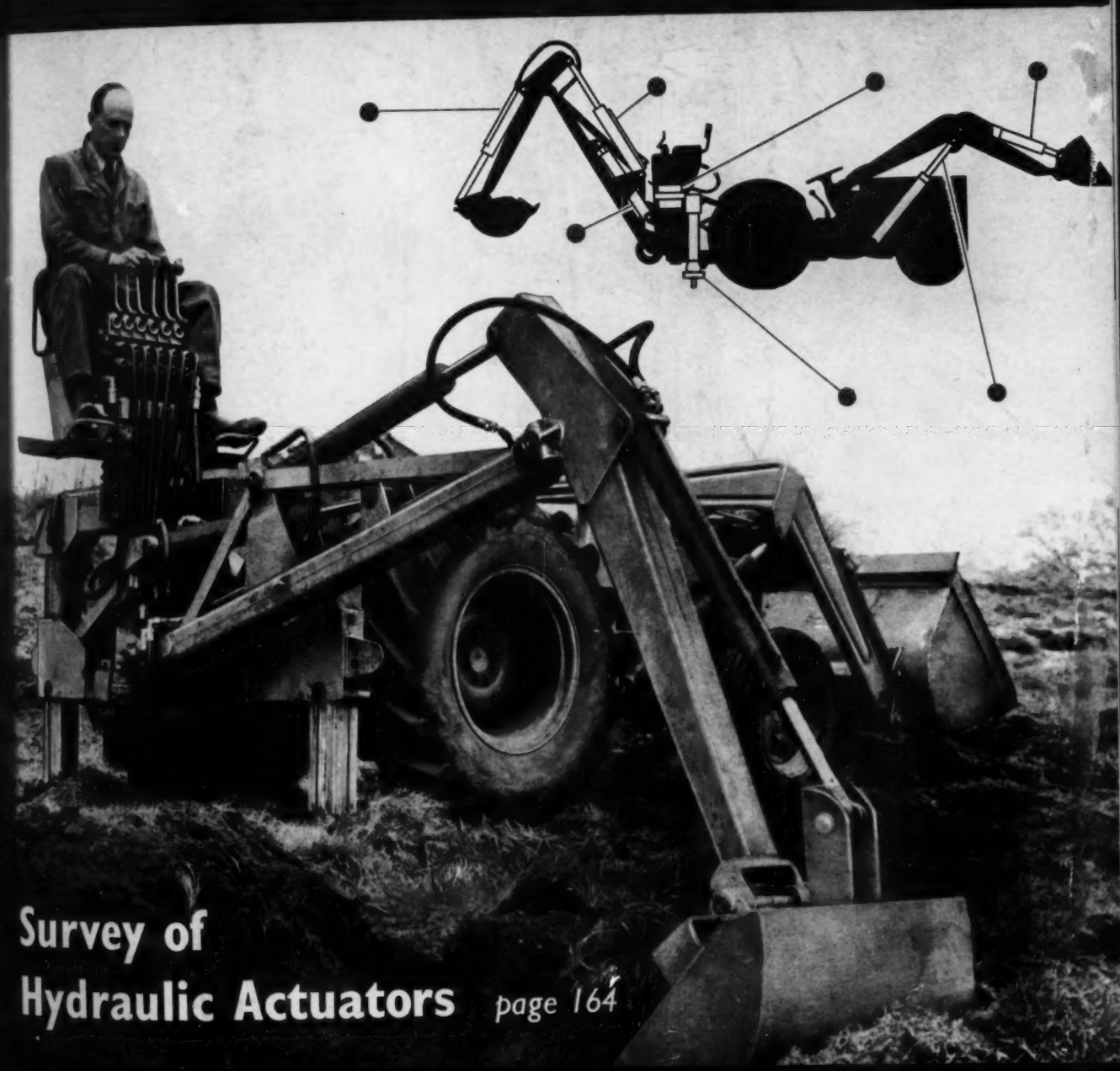

Survey of Hydraulic Actuators page 164

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Engineering Materials and Design

★ *The Magazine for Engineering Designers*

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COVER: The new Massey-Ferguson Davis digger and power shovel, the working movements of which are effected by means of Dowty hydraulic systems.

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ISSUE AT A GLANCE

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Dealing mainly with a special technique for the production of coils to a predetermined size.
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Examples of various applications of this new device.
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Résumés

L'ENTRAINEMENT HARMONIQUE : 2ème Partie

par C. W. Musser page 156

Cette seconde et dernière partie décrit les diverses applications des entrainements mécaniques à rapport constant pour la transmission d'energie, le positionnement angulaire et la transformation des mouvements.

ETUDE DES COMMANDES HYDRAULIQUES

par J. A. Coates page 164

L'auteur traite des divers aspects du dessin d'appareils comprenant des commandes hydrauliques et qui offrent à l'ingénieur un moyen compact de commander à distance des opérations dans de nombreuses installations. Il donne, également, une liste des principaux fabricants.

ISOLEMENT D'ENROULEMENTS POUR MACHINES TRACTRICES: 2ème Partie

par W. Duckett page 148

Deuxième d'une série de trois articles traitant respectivement des isolements catégories B, F et H. L'auteur s'occupe principalement d'une technique de presse spéciale qui permet de produire des bobines de dimensions déterminées.

NORMES ET NORMALISATION DANS L'ECONOMIE NATIONALE

par le Dr. H. M. Glass page 172

L'article est constitué d'une série d'extraits d'une communication présentée par l'auteur dans un cours sur la Normalisation dans l'Industrie Mécanique organisé par le Collège de Technologie d'Huddersfield.

Kurzreferate

DER HARMONISCHE ANTRIEB : TEIL 2

C. W. Musser Seite 156

Dieser abschliessende Artikel beschreibt verschiedene Anwendungen eines mechanischen Antriebs mit fester Übersetzung in Kraftübertragungen, Winkeleinstellungen oder Bewegungskonversion.

ÜBERSICHT ÜBER HYDRAULISCHE ANTRIEBE

J. A. Coates Seite 164

Der Verfasser befasst sich mit den verschiedenen Aspekten von Konstruktionen mit hydraulischen Antrieben, welche dem Konstrukteur ein kompaktes Mittel für ferngesteuerten Betrieb an die Hand geben. Der Artikel bringt ebenfalls eine Liste der hauptächlichen Erzeugerfirmen.

ISOLIERUNG DER WICKLUNGEN VON TRAKTIONSMASCHINEN: TEIL 2

von W. Duckett Seite 148

Der zweite einer Serie von drei Artikeln, die sich mit Isolierungen der Klassen B, F und H befassen. Der Verfasser bespricht hauptsächlich ein besonderes Pressverfahren zur Herstellung von Spulen bestimmter Grössen.

NORMEN UND NORMALISIERUNG IN DER NATIONAL-WIRTSCHAFT

Dr. H. M. Glass Seite 172

Der Artikel bringt Auszüge aus einem Artikel des Verfassers über Standardisierung im Maschinenbau, der in der Form einer Vorlesung vor dem Huddersfield College of Technology abgehalten wurde.

Резюме

ГАРМОНИЧНАЯ ТЯГА: ЧАСТЬ 2-ая

С. В. Массер стр. 156

Заключительная часть статьи, описывающей новый вид механической тяги постоянного коэффициента для силовых передач, углового расставления или преобразования движения.

ОБЗОР ГИДРАВЛИЧЕСКИХ ПУСКОВЫХ МОТОРОВ

эс. А. Котс стр. 164

В статье рассматриваются различные виды конструкции, включающие гидравлические пусковые моторы, дающие конструктору компактный метод управления на расстоянии на целом ряде установок. Приводится также списоок главных фабрикантов в этой области.

ИЗОЛЯЦИЯ ОБМОТОК ДЛЯ ДВИГАТЕЛЕЙ ТЯГИ: ЧАСТЬ 2-ая

В. Дакетт стр. 148

Вторая из трех статей, расматривающих изоляцию категорий B, F и H. Внимание уделяется главным образом особой технике прессовки для производства обмоток заранее установленных размеров.

НОРМК И СТАНДАРТИЗАЦИЯ В НАРОДНОМ ХОЗЯЙСТВЕ

Др. Х. М. Гласс стр. 172

Статья приводит выдержки из доклада, зачитанного автором на курсах по вопросу стандартизации в машиностроении, организованных Технологическим Институтом города Huddersfield.

MATERIALS IN THE NEWS

Monthly Digest of Materials and Design News from Home and Abroad

High-temperature Transistor

IN CONTRAST TO most present-day transistors, which are made almost exclusively from germanium and silicon, and which cannot always meet the high-temperature requirements of existing and planned aircraft and space vehicles, a new silicon carbide transistor capable of operating at above 340 deg. C. has been developed by the Materials Laboratories (Pittsburgh, Pa., U.S.A.) of the Westinghouse Electric Corporation, in co-operation with the company's Semiconductor Department, at Youngwood, Pa. Germanium transistors can operate at temperatures no higher than about 90 deg. C., while the limit for silicon transistors is 200 deg. C.

Laboratory tests have shown that the new silicon carbide transistor amplifies and has power gains greater than unity up to 350 deg. C., and with further development Westinghouse hope to raise its upper operating temperature to more than 495 deg. C. Because of its great chemical stability and desirable electrical properties at elevated temperatures, silicon carbide, a hard crystalline material which, in impure form, is used as an abrasive in grinding wheels, is considered one of the most promising of transistor materials for use in these higher temperature ranges.

The new device is a uni-polar transistor, in contrast to the bi-polar type usually made from germanium and silicon in which the flow of electric current is regulated by the injection of electric charge carriers across a junction built into the semiconductor material. The uni-polar transistor, on the other hand, acts more like a valve which opens or closes to regulate the electron flow across the junction.

The semiconductor junction is built into the material by exposing it to vaporised aluminium at the white-hot temperature of 2,150 deg. C., the aluminium atoms diffusing into the silicon carbide crystal and changing its electrical behaviour from n-type material to p-type. The junction is formed where the two types meet, and the diffusion process is controlled to within a few millionths of an inch.

Design at the Boat Show

THE POPULARITY of the recent Boat Show, and the increasing interest in nautical activities, is obvious from the greater attention given to the detail design of engineering components. Previous Shows suggested that manufacturers were not sure whether public interest was permanent, and thus they appeared reluctant to commit themselves to new designs and tooling problems. The result was that many components in the past appeared lacking in thought or development. This year, happily, designers have concentrated on improving and introducing properly engineered products.

Among the many exhibits worthy of note was the 21 cc. Trojan Rice (marketed by Trojan Ltd.), claimed to be the world's smallest and lightest industrial engine, developing ¼ b.h.p. at 6,300 r.p.m. for a weight of 3¼ lb. The crankcase is fitted with a reed valve for induction, ignition being by flywheel magneto. The light alloy cylinder contains a steel liner.

Other small multi-cylinder engines on show were the Excelsior Seafarer II (10-15 h.p.) and III (15-25 h.p.). The latter engine, a three-cylinder model, has an overall length of 32¾ in. (complete with gearbox and reduction gear), a height of 16½ in., and a width of 13⅝ in. Its weight is 135 lb.

The Jabsco self-priming pump has been on the market for many years, and is unique in its construction as it employs a neoprene impeller, the blades of which deform to produce the necessary change in internal volume. The nil clearance in the housing means that the pump is instantly self-priming and absolutely quiet. It may be used at speeds of up to 1,750 r.p.m. and pressures up to 45 p.s.i., various models being available to suit specific applications. In addition to the standard bronze housings, stainless steel models are available where required for chemical and food applications. The Jabsco pump is distributed in the U.K. by Cleghorn, Waring and Co. Ltd.

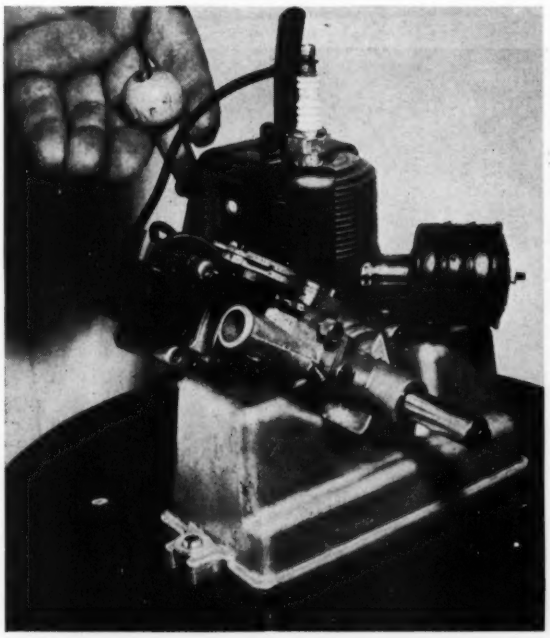
For utility purposes, the Atco boat-impeller has a universal application. This unit consists in essence of a tubular strut from which the propeller emerges at its lower end, the upper end containing an air-cooled motor. The unit is supported at some convenient position on the craft, the angle of tilt being manually controlled to suit conditions, and steerage being effected by swinging the complete unit.

As a development from the outboard motor, a number of companies were showing units consisting of an inboard mounted engine driving through a universal joint to an externally mounted vertical shaft which carries at its base the propeller. The advantages claimed are (a) the ability to use any make or type of engine; and (b), since the propeller unit is able to tilt, the chance of it being damaged is avoided. It is also possible to use a full depth transom.

By far the largest proportion of the smaller craft were constructed from reinforced plastics, a particular feature on some being the incorporation of a treatment into the first layer or coating to produce a decorative finish (mottled and coloured) on the interior of the craft, thus avoiding subsequent operations of lining or painting.

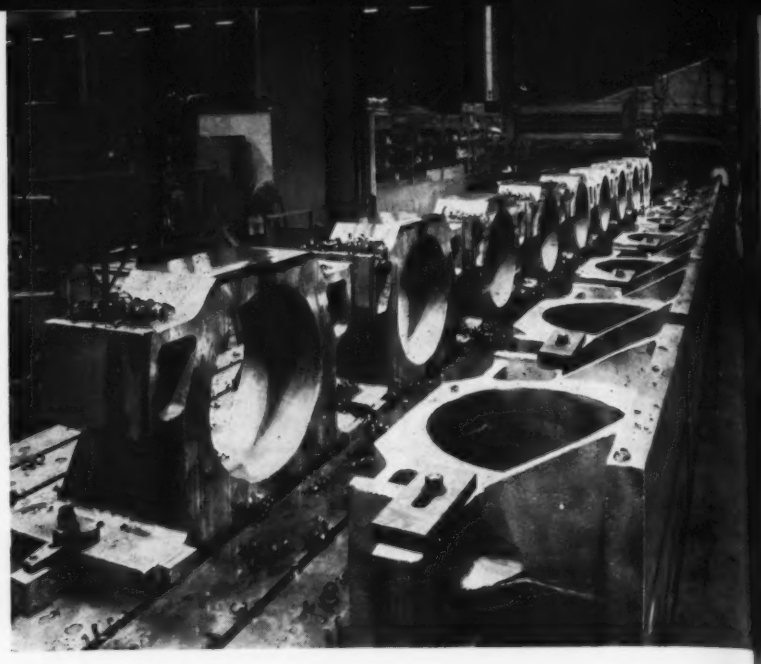
A large range of aluminium alloy extruded sections suitable for masts were on show, and many of these showed considerable ingenuity in the manner in which fittings such as pulley sheaves were incorporated.

The new single-cylinder two-stroke 21-cc. Trojan Rice engine, weighing only 3¼ lb.



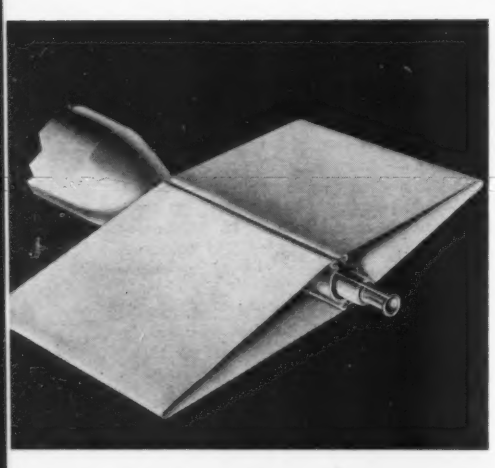
CHEAPER BY THE DOZEN

The simultaneous milling, at Boeing Airplane Company's works, of eighteen hinge-pin pillow blocks for Atlas ICBM sites has been made possible through the development of a new holder which permits the use of carbide throw-away cutting tips. Only one carbide tip is needed for milling all eighteen blocks on the planer.



MOVING BELT RADIATOR

Designed to overcome the problem of getting rid of the waste heat which will be generated in nuclear-powered space vehicles, the moving belt radiator shown below, developed by Rocketdyne (North American Aviation Inc.), is lighter in weight than previous radiator designs, and can withstand bombardment and penetration by the meteoroids encountered in space.



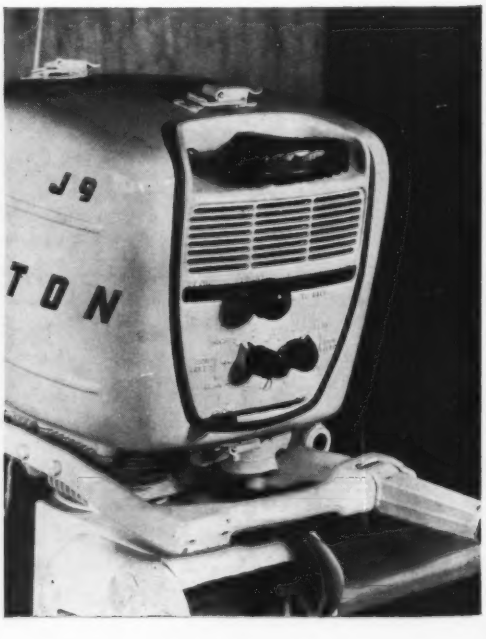
PICTURE NEWS
IN THE WORLD OF MATERIALS & DESIGN

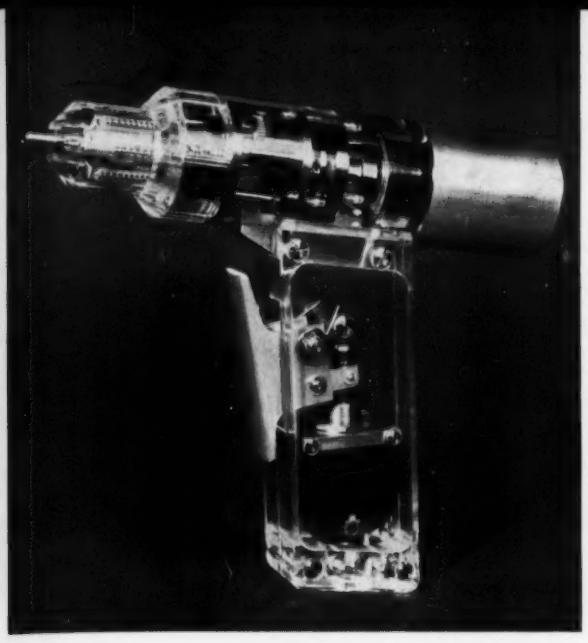
OUTBOARD ELEGANCE

Modern styling is a feature of this J9 Clinton 5 b.h.p. air-cooled outboard motor, which sports a control panel of practical simplicity. The motor has a recoil starter, weighs only 33 lb., and will run for 3½ hr. on 1 gall. of fuel.

TOOTH DESIGN IMPROVED

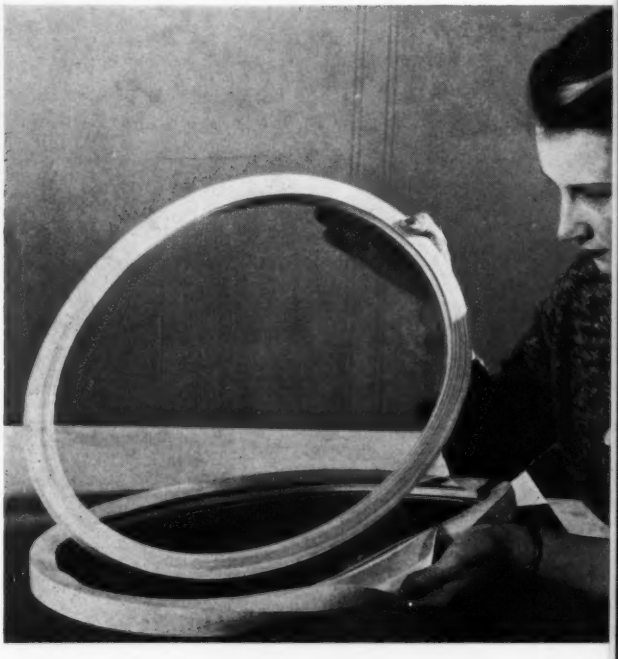
A new industrial Surform tool has been developed by Firth Cleveland Tool Ltd. for shaping hard metals such as mild steel, aluminium alloys, copper and brass. It is a fast cutting tool, and depends for its success on scientifically designed teeth, and a perforated blade to prevent clogging.





WINNING DESIGN

This futuristic looking model, a reset motor assembly, is the exhibit which won for Marconi apprentice John Palmer the Premier Award in the 1961 Physical Society Competition—the Silvanus P. Thompson Prize. Marconi apprentices have now won the premier award in this competition for three years in succession.

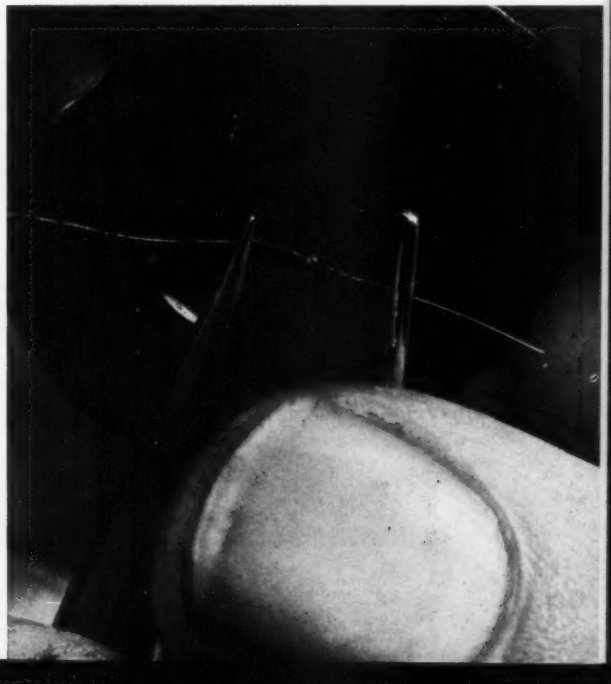


SILICONE SEALS

Faced with a sudden design change problem, the Engineering Research Division of A. V. Roe & Co. Ltd. took advantage of the "do-it-yourself" potential of Midland Silicones cold-curing silicone rubber to produce the urgently needed window seals shown on the right for the prototype Avro 748 civil airliner.

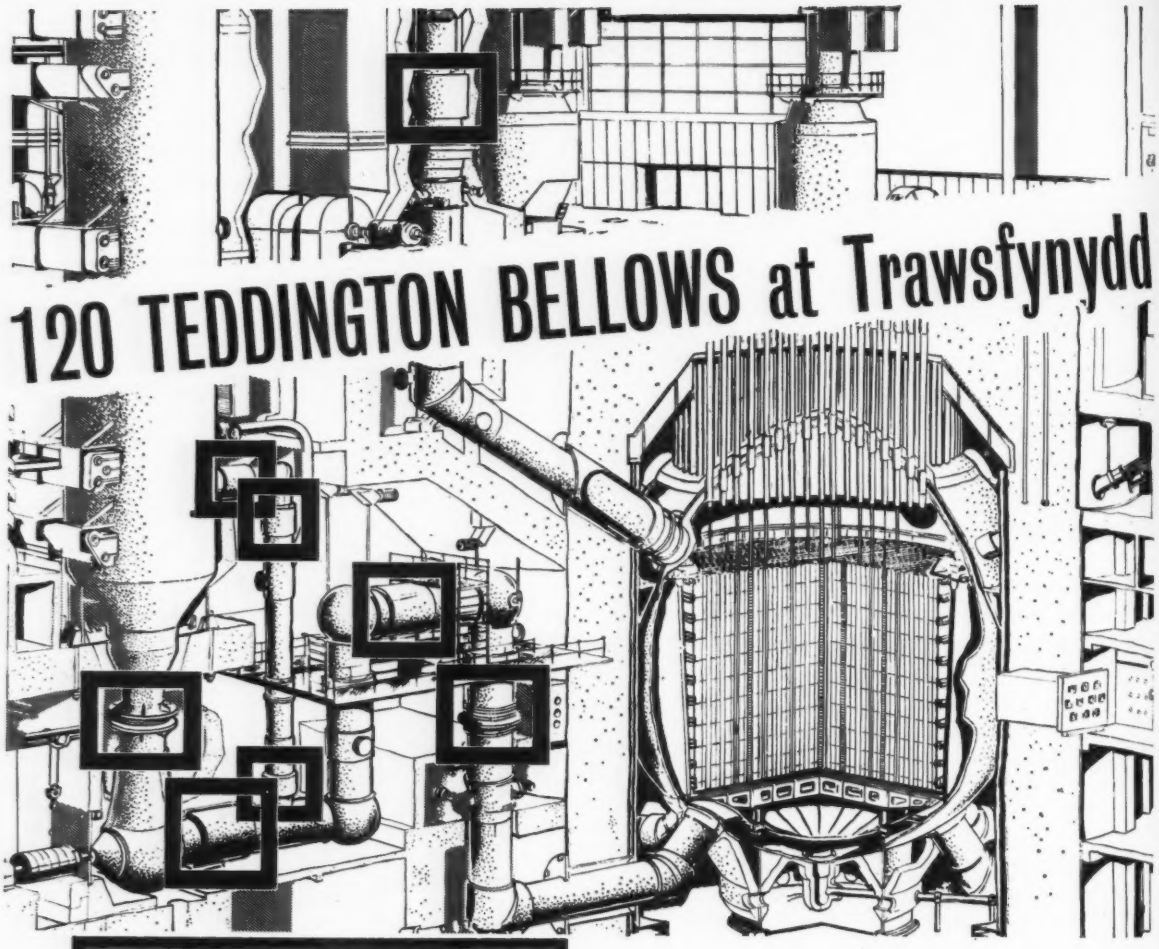
MINIATURE COMPUTOR

The IBM 3000 accounting system is a new small punched card set-up consisting of three basic units. In the picture on the left, the nearest machine is a combined card punch and verifier; in the centre is a desk top card sorter. The third machine is a combined calculator, accounting machine, reproducing punch and printer.



$1,000,000-PER-LB. BEAD

This midget bead thermistor, made of manganese nickel oxide, by Gulton Industries Inc. is used for measuring temperature on the surfaces of Polaris and Atlas missiles, and is so small that it easily passes through the eye of an ordinary needle. The bead is 0.01 in. in diameter, and is mounted on a wire 0.001 in. in diameter.



120 TEDDINGTON BELLOWS at Trawsfynydd

By courtesy of 'NUCLEAR POWER'

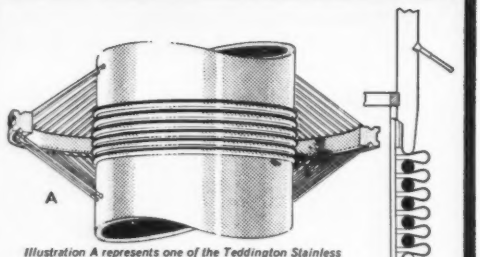
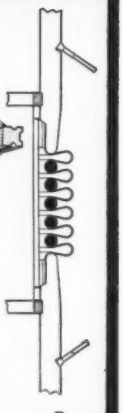


Illustration A represents one of the Teddington Stainless Steel Bellows supplied to Trawsfynydd with a novel form of restraint designed by Richardsons, Westgarth & Co. Ltd. (a member of Atomic Power Constructions Ltd.). This avoids the use of highly stressed hinge pins and permits a complete gimbal movement.

Illustration B indicates a section of Teddington Bellows, showing the restraining rings for extra strength which are a feature of this bellows design.



NO LESS THAN 84 BELLOWS 66" diameter and 36 BELLOWS 42" diameter, all of butt-welded stainless steel manufacture, are being fitted at Trawsfynydd to take up movement in the CO_2 cooling gas ducts.

Teddington secured this order only after many exhaustive tests including an accelerated life test equivalent to 20 years full operation. In addition, the larger size bellows were subjected to over-pressure tests of 1680 p.s.i.g. without developing a leak. Wherever pipe-work is subjected to vibration and movement in any direction owing to conditions of temperature and pressure, a Teddington bellows with a suitable end fitting will solve the problem. Write for full details of our range.

TEDDINGTON AIRCRAFT CONTROLS LIMITED

(INDUSTRIAL BELLOWS DIVISION),
AMMANFORD, CARMS.

Made under Licence from the Solar Aircraft Co. California, U.S.A.

MAD Units in Computers

THE AIMS OF RESEARCH in computer design are towards smaller, less expensive, more versatile and more reliable equipment. Multi-aperture devices (MADs) have been developed as computer elements at the Stanford Research Institute. These devices look like the earlier magnetic cores except that small apertures are placed in the ring forming the major central aperture. They have been used as the chief components of an all-magnetic logic unit that points the way to more complex all-magnetic computers. All-magnetic computers have certain advantages over equipment using transistors, because the ferrite composition is immune to nuclear radiation and the information output can be indicated visually by lights powered directly from the MADs.

Increasing Interest in Controlled Atmospheres

ONE OF THE MOST SIGNIFICANT post-war advances in the heat-treatment field has been the development of controlled atmospheres for use in a wide range of processes. A recent article, by L. G. W. Palethorpe, published in the *Wild-Barfield Heat-Treatment Journal* describes some of the different types of atmosphere available and their application to prevent the scaling of metals during heat-treament and/or to modify the surface layers of metals. Controlled atmospheres, for example, may be used to prevent decarburisation and oxidation of medium and high carbon steels during the heating cycle. Furthermore they can permit the addition of carbon and/or nitrogen in controlled amounts to the surface layers of suitable steels in gas carburising, carbonitriding and nitriding.

Town's gas, although cheap and readily available, has a number of drawbacks, but it can be modified by adding small quantities of ammonia (for carbonitriding mild steel), or it can be reacted with controlled amounts of air to form a carrier gas. With suitable hydrocarbon additions, this mixture is commonly employed for carburising. The liquid petroleum gases propane and butane are of growing importance, because not only are they more consistent and pure than town's gas but, if used in large quantities, they are also competitive with it. Recent developments have tended to increase the use of special bottled gases, such as argon and helium, particularly in vacuum furnaces, and for the heat-treatment of refractory metals.

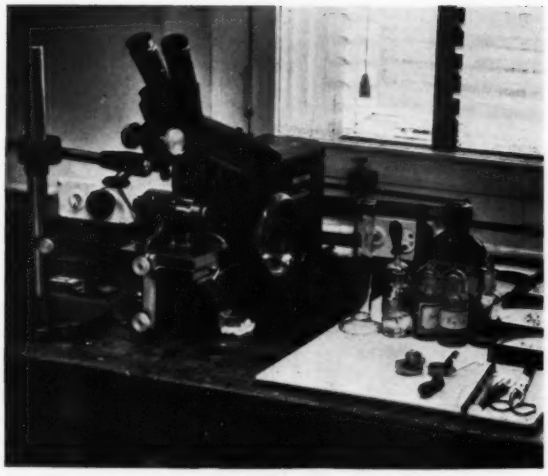
Most special atmospheres contain either hydrogen or carbon monoxide, either of which when mixed with air may be very explosive. Therefore, the design of the furnace and the accurate control of the atmosphere are vital for the successful use of these processes. Although some managements have been reluctant in the past to employ controlled atmospheres, increased experience with properly designed plant has shown that they can be employed economically and safely.

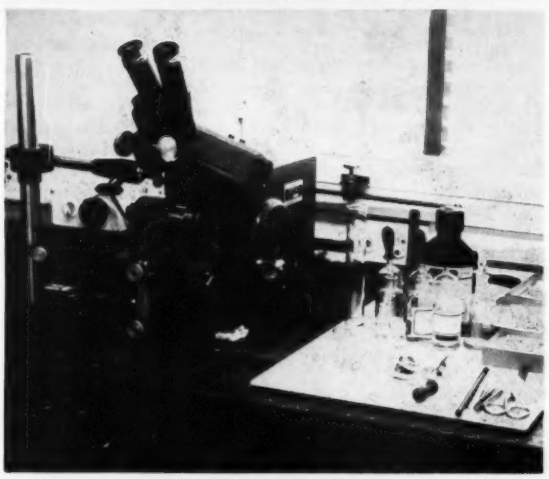
Design of Equipment for Human Use

A COURSE INTENDED for staff concerned with the design of machines and equipment of all kinds which have to be manually operated or controlled has been arranged by the Engineering & Allied Employers West of England Association. To obtain maximum efficiency, it is essential that the equipment designer should take into consideration both the characteristics of machines and the capacities of operators. Design engineers know a great deal about how machines work and what may be expected from them, but they have relatively little information about the human operator. This course is intended to help remedy the deficiency in this field of knowledge, which is known as ergonomics.

It will be conducted by K. F. H. Murrell, M.A., a member of the Department of Psychology at Bristol University, who was previously in charge of ergonomics at Tube Investments Ltd., and who is well qualified in the theory and practice of the subject. He will be assisted by Dr. Stephen Griew, lecturer in the same department, and by distinguished visiting lecturers in some specialised subjects.

The course will be restricted to twelve members, so that thorough discussion can take place and some practical work can be carried out. It will be held at Engineers' House, Clifton Down, Bristol, from February 27 to March 10, and November 20 to December 1.





Compare these photographs—the top one was developed using the Cintel electronic enlarger, the bottom one without electronic control.

Electronic Enlarger

THE CINTEL Electronic Photographic Contact Printer has been further developed for use with an enlarger, and comprises a scanning head, an optical head and a controlled unit. The cathode ray tube, which is mounted in the scanning head, replaces the normal cold-cathode light source, and the optical head is positioned to receive light passing through the enlarging lens. The control unit, which is produced in console form, houses all the electronic equipment. An exposure timer and a density compression control are provided.

In operation, the negative is scanned by a flying spot of light which passes through the negative and exposes the paper. The changes in light level due to density variations in the negative are recorded by the optical unit, and fed back to control the instantaneous brightness value of the flying spot. Thus the illumination source is varying in brightness at all times in direct relation to the density variations in the negative.

By this means, the density range of the negative can be compressed. This refers to the mean density of the negative over the area of the scanning spot. Fine details within this area will receive a normal exposure. Consequently the final print can have the fine detail in high contrast with a reduced overall contrast for larger areas, i.e. high light and shadow regions.

Because the illumination is directly proportional to the negative density, it is possible to realise a constant exposure time for a wide range of negatives, the actual exposure time being related to the speed of the printing paper and not to the average density of the negative.

TUFNOL SIGNS OF THE TIMES

Crow-sign of Tufnol

Those people born under the sign of the Crow are destined to assume the mantle of responsibility. They find the shortest route to the top of their profession is a straight line—as the Crow flies—and become chief purchasing officers, chief engineers, chief draughtsmen and chief designers. Crow men have the knack of making the best of the materials they have at hand. Yet they are always on the look-out for better things. Crow men are perfectionists. They yearn for one material that combines the properties of many materials—a material that is light yet strong and hardwearing, resistant to corrosion and a good electrical insulator. They also expect this ideal material to resist deterioration in storage, to machine easily with ordinary tools, and to be available in sheets, tubes, rods, angles and channels. Many Crow men have already discovered this remarkable material—"CROW" brand Tufnol. They have also discovered that Tufnol is available in eleven other brands, each with pre-determined properties. *All* brands of Tufnol are laminated plastics; each formulated to satisfy specific requirements. If your birthday falls between January 1st and December 31st, this could be your lucky week—the week you discovered Tufnol.

'Phone or write to your local Tufnol Branch Office and we predict you'll thank your lucky stars.

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Tufnol Limited,
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PI

THE APRIL ISSUE

of *Engineering Materials and Design* will include the following main features:

An Introduction to the Problem of Metal Fatigue
Describing the nature of fatigue failure, and the factors affecting fatigue strength.

Insulation of Windings for Traction Machines: Part 3
Dealing mainly with a special technique for the production of coils to a predetermined size (using Class H insulation).

Survey of Hydraulic Actuators: Part 2

Butyl Rubber
Brief description of the unique properties of this material.

Research News at the Physical Society Exhibition

Aluminium nitride is being developed to utilise its special properties. It is a strong, hard insulating material, and is expected to have uses similar to silicon nitride, but it may prove superior in contact with molten aluminium. For example, it may be used as a container material, or as a thermocouple sheath. *Boron phosphide* is also under development, and may be used for transistors. (British Ceramic Research Association.)

Trace storage using conventional cathode ray tubes has been demonstrated using a new screen material which gives a normal blue fluorescence on first excitation, followed by a green afterglow. Energy still stored within the phosphor can be excited by infra-red illumination after the green after-glow has died away, and therefore several viewings can be taken in succession, if necessary spaced some minutes apart. (Electronic Tubes Ltd.)

An evolute camera unit has been designed to reproduce on a single flat plate an image of the complete surface of a cylindrical specimen. It has been used to make permanent records of the condition of short lengths of cast iron and steel pipes after they have been subjected to soil corrosion. (British Iron & Steel Research Association.)

An extrusion speed transmitter has been developed for continuously measuring the ram speed of hydraulic extrusion presses or other machine movements that can be coupled to the transmitter. It converts this mechanical quantity into a proportional electric current suitable for operating indicators and recorders. (Cambridge Instrument Co. Ltd.)

A frictionless propeller meter has been developed for measuring water flow in pipes. Static friction is eliminated by mounting the propeller in a hydrostatic bearing so that only viscous friction has to be overcome. A linear relationship between flow velocity and propeller speed is obtained over a wide range of flow rates, particularly at low flow rates. (National Engineering Laboratory.)

Self-bonded silicon carbide has been made in many shapes by powder pressing and firing, and is said to retain its strength well at high temperatures. Conventional silicon carbide bonded by other materials has limited high temperature performance. Other methods of forming the self-bonded material, e.g. extrusion and casting, are being investigated. (British Ceramic Research Association.)

A high-temperature automatic recording balance is now available, and is claimed to weigh a sample continuously at 1550 deg. C. to an accuracy exceeding 0.001 gm. An integral recorder measures weight and temperature against a time scale of up to twenty days duration. (Stanton Instruments Ltd.)

An ultra high-speed framing camera is capable of exposing film at rates up to 8,000,000 frames per sec. Incoming light is reflected onto the film from a mirror which can rotate at up to 6,000 revolutions per sec., and an electronic synchronising unit ensures that the event being filmed occurs when the mirror is at a suitable angle. (Barr & Stroud Ltd.)

Tungsten filament lamps into which iodine vapour has been introduced are said to give increased life and reduced bulb blackening. It is stated that these improvements are obtained by a reduction in the rate of evaporation of the tungsten filament. Provided the bulb temperature is high enough, the iodine reacts with evaporated tungsten before it reaches the wall, but decomposition occurs near the filament; in this way the evaporated tungsten is confined to the region of the filament. (G.E.C. Research Laboratories.)

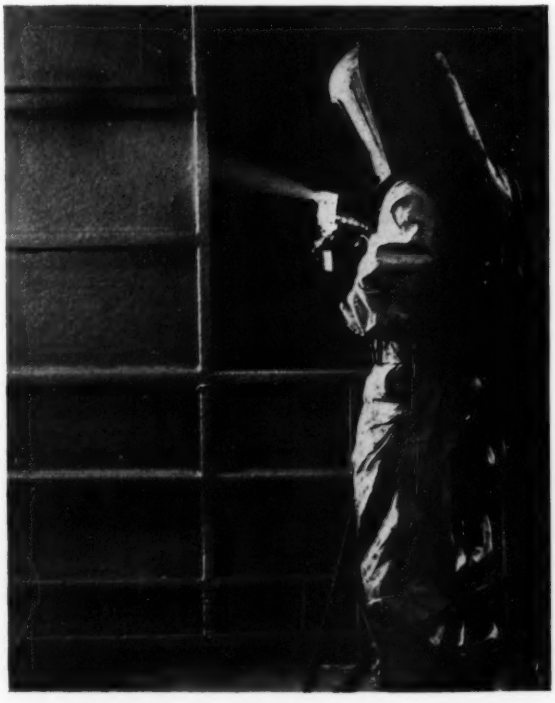
High-speed printing by a new method may be of use for computers and other data processing devices. The time taken to record a single character on magnetic tape is about one millionth of a second, and the recording heads are spaced at intervals of 0.01 in. A magnetic principle is used, and patterns are made with a suspension of fine iron powder. (Northern Polytechnic.)

A cold cathode emitter, consisting of a coating of a thin layer of magnesium oxide on metal, has shown the property of passing a very small stable current with the dissipation of very little power, combined with the ability to pass short bursts of very high current. Although nominally a cold cathode, special cooling is necessary for emissions greater than 2-3 mA./cm^2. (Post Office Engineering Department Research Station.)

Spraying Rigid Foam Insulation

A new design of spraying equipment, by J. W. Roberts Ltd., was recently demonstrated for rigid polyurethane foam. A metering unit controls the delivery of materials to ensure that they are in correct proportion, and several unique features have been embodied in the equipment to improve the quality of the foam and its ease of application. Foam can be sprayed directly onto surfaces to be insulated, and apart from horizontal surfaces the maximum thickness which can be applied in one coat is approximately $\frac{1}{4}$ in. Greater thicknesses can be obtained by multiple coating. The rigid polyurethane foam is not an incombustible material, but a flame propagation test indicates that when used as a lining in a compartment it is not likely to hasten the development of a fire involving other combustible materials. Where coatings applied to steel plates are 6 in. or more in thickness, arc welding on the reverse side of the plates up to $\frac{1}{8}$ in. thickness has shown only negligible damage to the coating in the vicinity of the weld. The coatings follow contoured surfaces or shaped cavities, and can be easily cut and shaped if pre-formed.

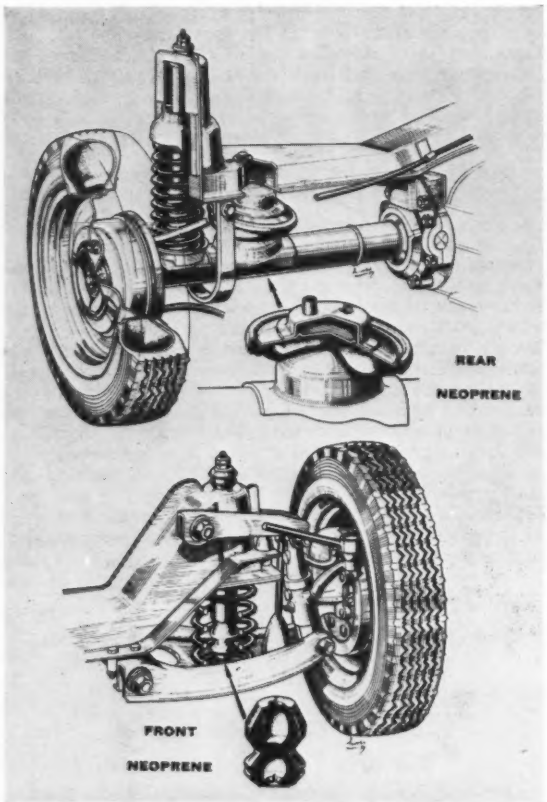
Polyurethane foam being used to insulate a controlled-temperature banana van.



Rubber Suspensions

IN THE 1961 Brussels Motor Show, two models were exhibited from the Austin light commercial vehicle range—the Seven ½-ton van, and the short-wheel-base Gipsy 4 x 4, both showing a break with tradition by abandoning the orthodox coil or leaf suspension medium. Both models employ rubber springing (on different principles) which is independent on all four wheels, requires no maintenance, and is said to be unbreakable and therefore a match for the notorious pavé surfaces of many Belgian roads.

A patented aerostable rear suspension has recently been introduced by Renault on three of their models. The new



Front and rear suspension units of the new Renault Dauphine, showing the position of the neoprene air cushions.

system incorporates the advantages of both leaf spring and rubber suspension by using a neoprene air cushion and steel springs. As a result, when the load in the car increases the springs take up the additional weight and ensure a comfortable ride irrespective of the number of passengers.

Stainless Steel Fuel Tank

A TOUGH BUT LIGHTWEIGHT pressurised stainless steel structure forms the main body of the U.S. Air Force's huge Atlas, America's first intercontinental ballistic missile. Details of the Atlas propellant tank (which is so thin that it is kept under pressure to retain its shape) were revealed for the first time recently by the Ballistic Missile Division of the U.S. Air Force's Air Research and Development Command, and Convair (Astronautics) Division of General Dynamics Corporation.

The tank, measuring about 60 ft. in length and 10 ft. in diameter, has no internal framework. From the propulsion section to the nose cone, the Atlas' thin-gauge tank walls form the complete airframe. While a structure of such light weight would seemingly be fragile, the Atlas is actually extremely tough. Its thinnest wall section meets a specification for minimum tensile strength of 200,000 p.s.i.

Helium, fed into the space remaining at the top of the propellant levels, does the dual job of helping to force propellants to the 360,000 lb. thrust Atlas engines; this same helium keeps the balloon-like Atlas skin drum-tight throughout the severe loads of launching and flight. It cuts final flight weight—a major factor in range—to an almost irreducible minimum.

A special cold-rolled austenitic steel (AISI grade 301) was perfected for the Atlas tank, and Convair worked with the welding industry to develop new welding techniques and equipment for fabrication. This steel, produced by the Washington Steel Corporation, of Washington, is noted for its toughness, strength-to-weight ratio, ease of handling and resistance to heat, cold and corrosion. It is also easily formed and welded.

Skin gauges vary throughout the structure, being tailored to meet local stresses. Several of the twenty-seven sections are thinner than the wall of a milk carton. The heaviest skin gauge is less than 0.04 in.

Design Appreciation Course

THE THIRD Council of Industrial Design design appreciation course for apprentices and junior engineers will take place in March and April. It will be held at Reigate in two residential periods, each of four days, separated by an individual study period of four weeks. The residential periods include visits to factories, The Design Centre and schools of industrial design (engineering). In the month of individual study, each student makes a design analysis of two articles seen in the Centre. During the final residential period, these analyses are presented to the class by the student and a detailed criticism is given by one of the Council's industrial officers.

The course is not intended as a short cut to industrial design. Its aim is rather to increase design appreciation and create an awareness of the industrial designer's place in the factory team. A detailed programme for the course is not yet available, but lectures will probably include: "Focus on Design"; "An Outline of Present-day Concepts"; "Design in Presentation"; "An Analysis of Design"; "Human Factors in Design"; "Form and Composition"; and "How a Designer Works." Applications and requests for further information should be addressed to Miss Sydney Foott, Education Section, CoID, 28 Haymarket, London, S.W.1.

Engineering Aspects of Lubrication

AN INTENSIVE COURSE covering the subject of lubrication from the engineering aspect will be given from May 1-19. About half the lectures will be on the theory of fluid film and thin film lubrication and wear, the remainder dealing mainly with the materials normally used. The properties of natural and synthetic oils and additives as well as solid lubricants will be examined, and their suitability for various applications, test procedures and specification will be discussed. Porous metal bearings, and the choice and limitations of bearing metals, will also be dealt with.

Throughout the course, which will be full-time, the treatment will be fundamental, but will lead to an appreciation and assessment of current practice. Sufficient tutorial periods will be allowed for the detailed working out of problems, and laboratory periods will provide for practical work to be carried out on a number of rigs for the study of full fluid and thin film lubrication. American practice will be discussed by a speaker from the General Electric Company, New York.

Mathematics to G.C.E. advanced level will be assumed. Further information and forms of application may be obtained from the Registrar, Imperial College of Science and Technology, London, S.W.7.

FOR FURTHER INFORMATION:—

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J. W. Roberts Ltd., Chorley New Road, Horwich, Bolton.

General Dynamics Corporation, 3165 Pacific Highway, San Diego, California.

TRAINING IN APPLICATION

OPENING the recent one-day Conference on Fluid Power, DR. CHAPMAN, principal of Hatfield Technical College, drew attention to the lack of facilities in the U.K. for teaching applied hydraulics and pneumatics—or to use a more popular term, fluid power. In the U.S.A., he said, there were some fifty-one colleges and universities running courses on this subject, eleven of these including practical workshop practice.

Fluid power is only one of the many subjects for which there is lack of applied science, and of course it is only one of the many problems facing education authorities today. The rapid changes and development taking place in industry are outpacing the present system of technical education, but there is some consolation to be found from the Government's intentions as given in the recent White Paper on "Better opportunities in Technical Education".

The blame for failing to keep abreast of modern requirements should not be allowed to fall entirely on education authorities—industry and the professional institutions are also to blame in some measure. Industry has often grumbled about the lack of suitably trained recruits, and yet, when individual companies have been asked for specific details regarding their requirements for recruits, the response has been in the main highly unsatisfactory. Companies just do not seem to know what they require, and even when courses are suggested to them their reactions are hardly encouraging.

Before coming into operation, it is necessary for any proposed course to be submitted to higher authority, to whom any change in the format of a course is often unwelcome; to them, for example, fluid mechanics means the traditional flow over a weir with V or square notches. To industry, fluid mechanics means loss of efficiency in pipes and through valves; and also, designing for production and to a cost basis with consideration to the type of labour available. Professional institutions appear to have views similar to examining bodies. Both education authorities and professional institutions should take courage, and after serious deliberation with leaders of industry, try an experimental course. There is a great deal to be said sometimes for the "suck it and see" method.

Hatfield Technical College is to be congratulated on its boldness coupled with forward thinking in organising a Fluid Power Conference to ascertain, in open discussion with leaders of industry, the best and most suitable training to obtain applied knowledge. Fluid power is increasingly important in modern technology, and if the U.K. is not to be an "also-ran" during the next decade then no time at all must be lost in teaching the right subjects to the right people.

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THOSE FOREIGN DIESELS

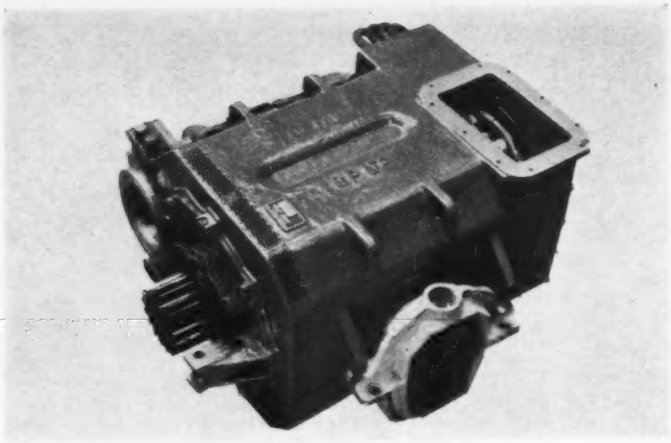
TOSSING criticism at British Railways is fast becoming a national sport—when nothing else seems to warrant attack there are always late running of trains and increasing fares to provide ammunition for commuters and the daily Press. Recently the railway authorities have come under very heavy fire as a result of breakdowns in new services involving diesel and 25-kV. electric stock. We feel sympathetic towards British Railways and the manufacturers whose equipment has failed, because we know something of the special difficulties arising in the design and manufacture of traction equipment. It is not appreciated even by engineers in closely allied branches of industry, let alone by the general public, that adequate testing of traction equipment before commissioning is extremely difficult, if not impossible. It takes many years' experience in service to build up a reliable railway system, and any brand-new service is bound to be afflicted with teething troubles. Even a minor fault may stop a train and hold up many travellers.

Not content with recent breakdowns, the railway critics have now opened up a new line of attack by saying that most of the diesel engines used on locomotives in this country are of foreign origin, implying that British firms are not capable of designing satisfactory engines. Let us look at the facts. Out of a total of 3,791 engines for locomotives, 1,051 are of foreign design and all of them were offered by British locomotive or engine firms, the policy of British Railways being to buy only engines built with British labour. The largest number of engines of foreign design are not German, as has been suggested, but Swiss, the figures being 448 and 603 respectively.

Even if we insist that the use of foreign designs was wrong, the position is clearly not so bad as it was made out to be. Nevertheless, it is worth pausing to consider whether the inclusion of some foreign designs was perhaps a good thing after all. Firms like M.A.N., in Germany, and Sulzer Brothers, in Switzerland, were among the first to take up the manufacture of diesel engines to the patents of Dr. Rudolf Diesel. In fact, Sulzer Brothers commenced the development of diesel engines as early as 1896, and in 1912 the world's first main-line diesel locomotive was engined by them. There can be no doubt that continental manufacturers have the decided advantage of having experienced a greater variety of uses for diesel engines over a much longer period than British firms, and the fact that some manufacturers in this country took the initiative and obtained licences to manufacture foreign engines shows that in their expert opinion this was more economical than starting a long and expensive development of new designs. Many British engine makers we have spoken to are confident that British-designed engines are as good as any produced on the Continent, but the more recent entry of U.K. firms into this field means that they have not yet built up the necessary experience to cover the whole range of speeds and powers required. We have complained many times before that far too many products in this country are built under foreign licences, but in railway diesels there seems to be a notable exception. To have pursued a 100 per cent British design policy in this case would have meant either delaying the changeover from steam or, more likely, having to purchase foreign-designed diesels built with foreign labour.

If we may turn from gamekeeper to poacher for a moment, we would like to conclude with a critical comment. The design of railway stock has improved in many ways over the years except in one important aspect, that of riding comfort. Coaches built thirty to forty years ago ride incomparably better than modern stock, and although we have asked many railway engineers why this is, none of them seems to know. Some have blamed the reduction in sprung weight, but surely this is not responsible, because on motorcars a much greater weight reduction has been achieved and at the same time comfort has improved enormously. Can anyone supply the answer?

The Editor



Crompton Parkinson type C171 traction motor with Class F insulation, now operating on British Railways.

PART 2 | INSULATION OF WINDINGS FOR TRACTION MACHINES

This second article of a series of three deals with Class F insulation, and describes the design of insulation on armature and field coils for use at temperatures up to 155 deg.C.

by W. DUCKETT

CLASS F INSULATION

ACCORDING to BS 2757:1956, Class F insulation must withstand a temperature of 155 deg. C. for long periods. It is employed on the windings for a proportion of the traction motors, main generators and various auxiliary machines at present being manufactured for British Railways in the current modernisation programme. As Class F insulation has only been officially recognised since 1956, there is considerably less experience of its service performance compared to the Class B materials discussed in the first part of this article (see February issue of *E.M.D.*). Many failures were encountered in the manufacturers' works and in service during the early development of Class F machines, but the information given here is confined to designs which have given satisfactory service at their maximum operating temperatures.

While it is not intended to discuss the production aspects of insulating traction machines in this article, it cannot be too strongly emphasised that production schedules must be rigidly adhered to if insulation failures are to be avoided. This applies particularly to drying times and temperatures, both before and after impregnation, and it has a special significance with Class F insulation, which incorporates a considerable amount of glass fibre tape. Although glass fibre does not absorb varnish, it acts as a carrier and is liable to trap moisture or varnish solvents, which can cause trouble not only during manufacturers' tests but later in service.

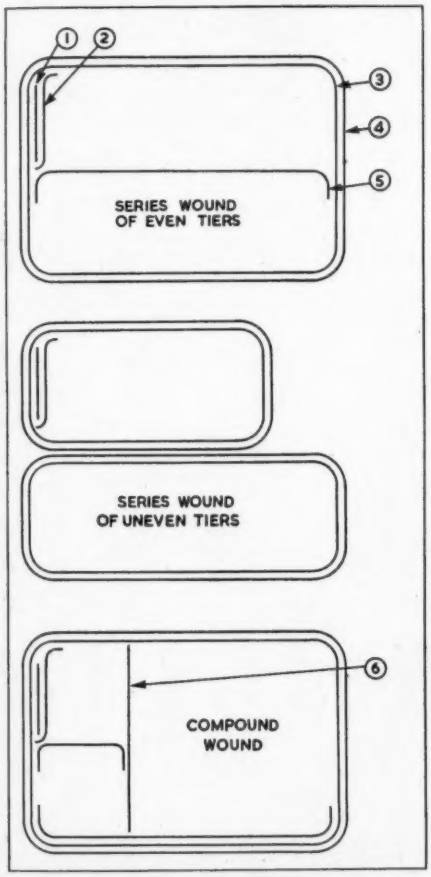
Individual turns are usually insulated with asbestos paper, glass and mica combination, or varnished glass cloth. A varnished glass cloth based on an epoxy resin was inspired by the author, and later successfully developed by Lewis Berger (Gt. Britain) Ltd. This material will withstand 200 deg. C. for 100 hr., followed by cooling and bending round a $\frac{1}{16}$-in. dia. mandrel, without cracking. The cloth is approx. 0·0045 in. thick, and has a number of advantages over mica combination in that it can be stored without significant deterioration, and can be cut into strips of almost indefinite length. It can also be used for insulation to earth. It is thinner and more even in thickness than mica combination, and therefore gives coils of more even construction and smaller size. A word of warning should be added, however, that where insulation is subjected to severe compression or impact, such as the separators between tiers on series wound field coils, or interleaf insulation on thick copper strip (more than 0·04 in. thick) which is hammered during the winding operation to ensure a tight coil, then it is advisable to employ mica combination. In such cases a single layer of mica splittings is used for interleaf insulation, and three layers of mica for separators. In either case the mica is protected on both sides by 0·002-in. woven glass cloth, and shellac varnish should be used.

The special varnished glass cloth can be applied as main insulation to earth in half lap layers, the number of layers varying from two layers for up to and including 750-V. machines, to three layers for up to and including 1,500-V. machines. A final covering of woven glass tape (0·01 in. thick) should be applied for mechanical protection. A specially woven tape with an increased number of warp and weft threads per inch was developed by Jones, Stroud & Co. Ltd. in conjunction with the author. This material allows more varnish to be retained.

As with Class B insulation, the field and armature coils can be produced to predetermined dimensions by a pressing operation, during which the impregnating varnish cures to give a hard, durable insulation. As the insulation consists mostly of woven glass fibre, the compression which takes place is only slight (about 1 per cent), but the important point is that air pockets are eliminated. A typical production schedule for field coils would be as follows:

1. Wound and insulated coils are dried at 110 deg. C. for 6-8 hr.
2. While hot, coils are immersed in varnish.
3. Air dried for 8-10 hr.
4. Coils inserted into pressing blocks (see Part 1, February *E.M.D.*).
5. Baked under pressure for 7 hr. at 170 deg. C.
6. Coated with heat-resisting enamel (Meggerlac).

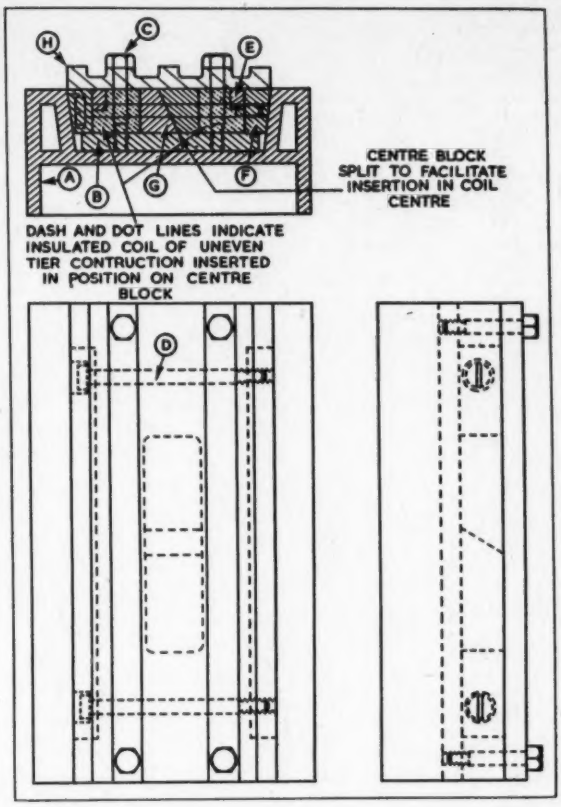
It is recommended that the series and shunt windings on compound wound field coils should be manufactured as separate components on large machines such as the main-line or shunter type diesel-electric locomotive. Not only does this facilitate manufacture, but it simplifies replacement of a coil if failure occurs in service. However, on small machines used for auxiliaries, there is usually insufficient space for this method of construction, and the shunt portion must be wound over the series portion.



DIAGRAMS INDICATING PORTIONS OF COIL WHERE VARIOUS INSULATIONS ARE APPLIED

1. BARE COPPER CONDUCTOR
2. GLASS AND MICA COMBINATION, ASBESTOS PAPER, OR VARNISHED GLASS CLOTH (EDGES TO OVERLAP ON TOP AND BOTTOM OF CONDUCTORS)
3. VARNISHED GLASS CLOTH
4. WOVEN GLASS TAPE
5. GLASS AND MICA COMBINATION
6. GLASS AND MICA COMBINATION

Insulation of (top) even tiers; (middle) uneven tiers; and (bottom) a compound coil.



A. PRESSING BOX
B. BOTTOM PLATE
C. LIGHTENING SCREWS
D. FIXING SCREWS
E. SIDE BLOCKS
F. SIDE WEDGES
G. CENTRE BLOCK
H. TOP PLATE

Pressing gear for field coils.

The conductor for the shunt winding is round copper wire, insulated with two lappings of glass fibre and wound on four layers of glass and mica combination which covers the series portion. After completing the shunt portion, the composite coil is pressed for 3 hr. at 160 deg. C. and, after cooling, a glass and mica combination sheet is cut to shape for reinforcement on the magnet side of the coil, extending $\frac{1}{8}$ in. down all sides. Main insulation to earth is now applied.

The calculation of coil dimensions follows the same general procedure as for Class B materials (see Part 1 of this article).

Compensating Windings

In the current modernisation programme for British Railways, the main generator on one type of diesel-electric main-line locomotive employs compensating windings on the main poles. This particular generator has an output of 1,530 kW., and is the largest ever produced in Europe. Compensating windings have seldom been used on traction machines, owing to the long and costly operation of repairing or replacing a faulty coil. To overcome this disadvantage a new design of pole construction and field assembly was developed by the author (B.P. Spec. No. 629,063:1949). The conductors for this type of winding are usually heavy

Method for Obtaining Predetermined Dimensions on Field Coils with Class F Insulation (all dimensions in inches).

Copper—no compression.
Presspahn Packing—assume no compression.
Varnished Glass Cloth—0·0045 thick, after 1 per cent compression = 0·0044.
Interleaf (when replacing varnished glass cloth)—
0·002 glass cloth.
0·0015 mica.
0·002 glass cloth.
0·0015 varnish.
0·001 allowance for building.
0·008 (after 1 per cent compression = 0·0079).

Woven Glass Tape—
0·003 thick, after 1 per cent compression = 0·0029.
Woven Glass Tape—0·01 thick, after 1 per cent compression = 0·0099.

Separators and Armature Core Insulation—
0·002 glass cloth.
0·0045 mica.
0·002 glass cloth.
0·0015 varnish.
0·0015 allowance for building.
0·0115 (after 1 per cent compression = 0·0114).

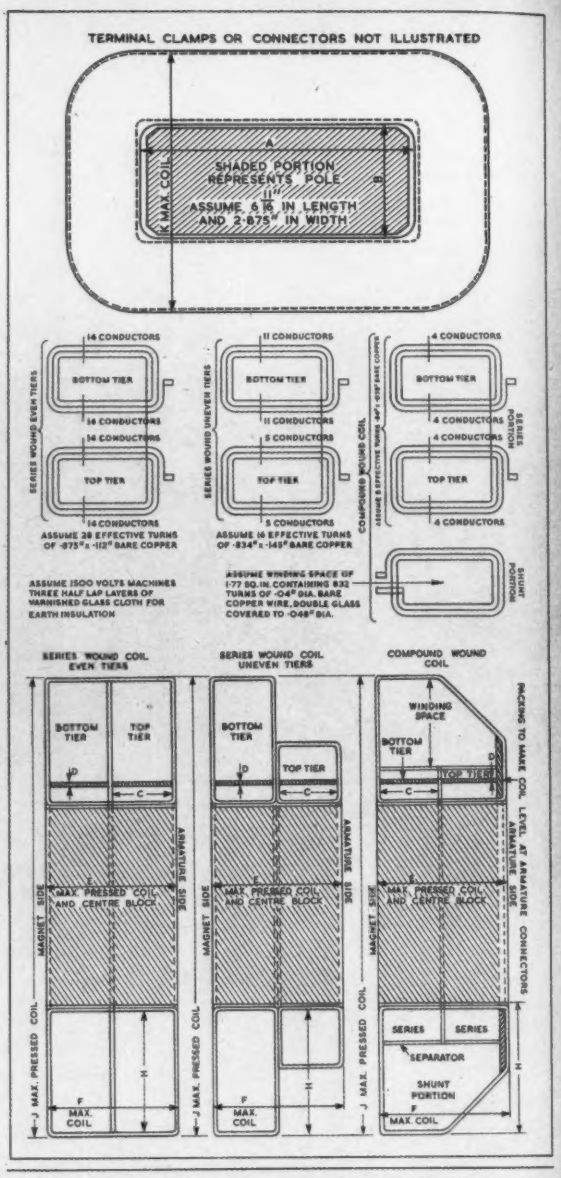
A centre block length = length of pole + 0·20.
B centre block width = width of pole + 0·07.
C conductor depth.
D conductor thickness.
E (**C** × 2) + compressed insulation thickness + packing on compound wound coils.
F **E** + 0·016 (final coating of heat-resisting enamel).
G number of conductors.
H (**G** × **D**) + [(**G** − 1) × 0·0044] + insulation thickness of width series portion + separator (+ shunt winding width + insulation thickness on compound coils).
J **B** + (**H** × 2).
L **E** divided by 2 (on series wound coil of uneven tiers).
M **G** in bottom tier − **G** in top tier × (**D** + insulation thickness of compressed interleaf insulation).

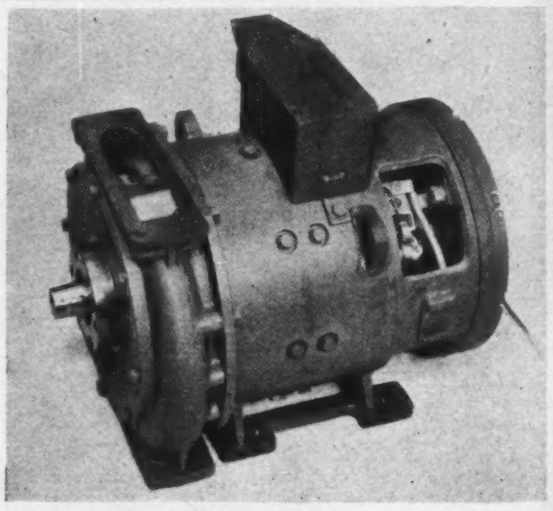
Series Wound Coil Even Tiers
E = 0·875 × 2 + 0·1214 = (say 1·871).
F = 1·871 + 0.016 = 1·887.
J = 2·945 + 3·4412 = 6·3862 (say 6·386).
K = 6·386 + 0·016 = 6·402.

Series Wound Coil Uneven Tiers
E = 0·834 × 2 + 0·2024 = 1·8704 (say 1·87).
F = 1·87 + 0·016 = 1·886.
J = 2·945 + 3·4432 = 6·3882 (say 6·388).
L = 0·935.
M = 0·896.

Compound Wound Coil
E = 0·840 × 2 + 0·1458 + 0·08 (packing) = 1·9058 (say 1·906).
F = 1·906 + 0·016 = 1·906.
J = 2·945 + 3·53 = 6·475 (say 6·47).
K = 6·47 + 0·016 = 6·486.

Note: On series wound coils, a curve could be drawn or a table made giving relative total insulation thicknesses varying according to voltage of machine and number of turns in winding. (All calculations are based on insulation thicknesses after 1 per cent compression.)


TERMINAL CLAMPS OR CONNECTORS NOT ILLUSTRATED
SHADED PORTION REPRESENTS POLE
ASSUME 6 1/8" IN LENGTH AND 2·875" IN WIDTH
MAX. COIL
SERIES WOUND EVEN TIERS
SERIES WOUND UNEVEN TIERS
COMPOUND WOUND COIL
BOTTOM TIER
TOP TIER
16 CONDUCTORS
11 CONDUCTORS
5 CONDUCTORS
4 CONDUCTORS
SERIES PORTION
SHUNT PORTION
ASSUME 28 EFFECTIVE TURNS OF ·875" x ·112" BARE COPPER
ASSUME 16 EFFECTIVE TURNS OF ·834" x ·145" BARE COPPER
ASSUME 1500 VOLTS MACHINES THREE HALF LAP LAYERS OF VARNISHED GLASS CLOTH FOR EARTH INSULATION
ASSUME WINDING SPACE OF 1·77 SQ. IN. CONTAINING 832 TURNS OF ·048" DIA. BARE COPPER WIRE, DOUBLE GLASS COVERED TO ·048" DIA.
SERIES WOUND COIL EVEN TIERS
SERIES WOUND COIL UNEVEN TIERS
COMPOUND WOUND COIL
WINDING SPACE
MAGNET SIDE
ARMATURE SIDE
MAX. PRESSED COIL AND CENTRE BLOCK
MAX. PRESSED COIL
MAX. COIL
SERIES
SEPARATOR
SHUNT PORTION
PACKING TO MAKE COIL LEVEL AT ARMATURE CONNECTORS



On the right is shown a Crompton Parkinson type CG3 compressor motor with Class F insulation, now operating on British Railways.

Method for Obtaining Predetermined Dimensions on Single-turn Armature Coils with Class F Insulation (all dimensions in inches).

Assume 800-1,500 *V., five coils per slot, with a conductor of* 0·550 × 0·045 *bare.*

7. bare conductor.
8. treated woven glass tape along conductors.
9. treated woven glass tape (to avoid movement).
10. wrappings along straight portion.
11. treated woven glass tape (coil overall).
12. treated woven glass tape (final covering).
13. superfine cotton tape (temporary) removed after pressing.

0·003 treated woven glass tape **8**, **9** and **11**—after 1 per cent compression = 0·0029.

Separate Wrappings in Conjunction with Each Other, **10**—
0·0055 mica and bonding varnish.
0·001 Melinex.
0·0065 (after 1 per cent compression = 0·0064).

12. 0·007 Treated Woven Glass Tape—after 1 per cent compression = 0·0069.
13. 0·0065 Superfine Cotton Tape—after 1 per cent compression = 0·0064.

First Pressing Depth—

1 × 0·5500 = 0·5500 (bare copper)	7
4 × 0·0029 = 0·0116	8
2 × 0·0029 = 0·0058	9
2 × 0·0064 = 0·0128	13
0·5802 (before removal of 13)	
= 0·5802 − 0·0128 (after removal of 13)	
= 0·5674.	

Second Pressing Depth—

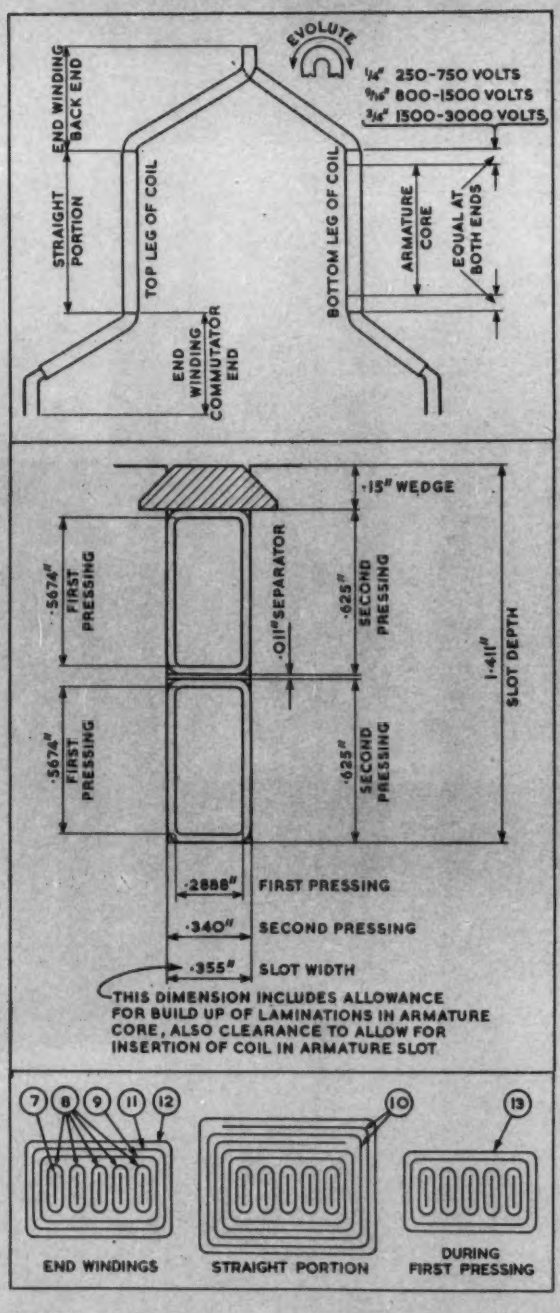
4 × 0·0029 = 0·0116	11
5 × 0·0064 = 0·0320	10
2 × 0·0069 = 0·0138	13
0·0574 (compressed insulation)	
Coil after first pressing = 0·5674	
Compressed insulation = 0·0574	
0·6248 (say 0·625)	

First Pressing Width—

5 × 0·045 = 0·2250 (bare copper)	7
20 × 0·0029 = 0·0580	8
2 × 0·0029 = 0·0058	9
2 × 0·0069 = 0·0138	13
0·3016 (before removal of 13)	
= 0·3016 − 0·0128 (after removal of 13)	
= 0·2888	

Second Pressing Width—

4 × 0·0029 = 0·0116	11
4 × 0·0064 = 0·0256	10
2 × 0·0069 = 0·0138	13
0·0510 (compressed insulation)	
Coil after first pressing = 0·2888	
Compressed Insulation = 0·0510	
0·3398 (say 0·340)	



Slot Depth—
0·150 armature slot wedge.
0·625 coil depth, top leg.
0·011 separator.
0·625 coil depth, bottom leg.
1·411

Slot Width—
0·340 coil width.
0·010 build up of armature laminations.
0·005 clearance.
0·355

Method for Obtaining Predetermined Dimensions on Two-turn Armature Coils with Class F Insulation (all dimensions in inches).

Assume 800-1,500 *V., five coils per slot, with a conductor of* 0·30 × 0·04. *bare, glass fibre covered to* 0·315 × 0·055.

14. bare conductor.
15. glass fibre covering.
16. treated woven glass tape.
17. glass and mica combination tape.
18. Melinex.
19. Melinex and mica combination.
20. wrappings along straight portion.
21. treated woven glass tape.

15. 0·015 Total Thickness of Covering on Conductors—after 1 per cent compression = 0·0148.

16. 0·003 Treated Woven Glass Tape—after 1 per cent compression = 0·0029.

17. Glass and Mica Combination Tape—

0·002	woven glass cloth.
0·0015	mica.
0·002	woven glass cloth.
0·0015	varnish.
0·001	allowance for building.
0·008	

18. 0·003 Melinex—after 1 per cent compression = 0·0029.

20. Separate Wrappings in Conjunction with Each Other—

0·0055	mica and bonding varnish.
0·001	Melinex.
0·0065	

21. 0·007 Treated Woven Glass Tape—

Depth after pressing—

2 × 0·30	= 0·6000	**14**
2 × 0·0148	= 0·0296	**15**
2 × 0·0029	= 0·0058	**18**
2 × 0·0029	= 0·0058	**16**
	0·6412	

Width after pressing—

5 × 0·04	= 0·2000	**14**
5 × 0·0148	= 0·0740	**15**
2 × 0·0029	= 0·0058	**18**
2 × 0·0029	= 0·0058	**16**
	0·2856	

Coil after Pressing = 0·6412

4 × 0·008	= 0·0320	**17**
5 × 0·0065	= 0·0325	**20**
2 × 0·007	= 0·0140	**21**
	0·7197	(say 0·720 coil depth).

Coil after Pressing = 0·2856

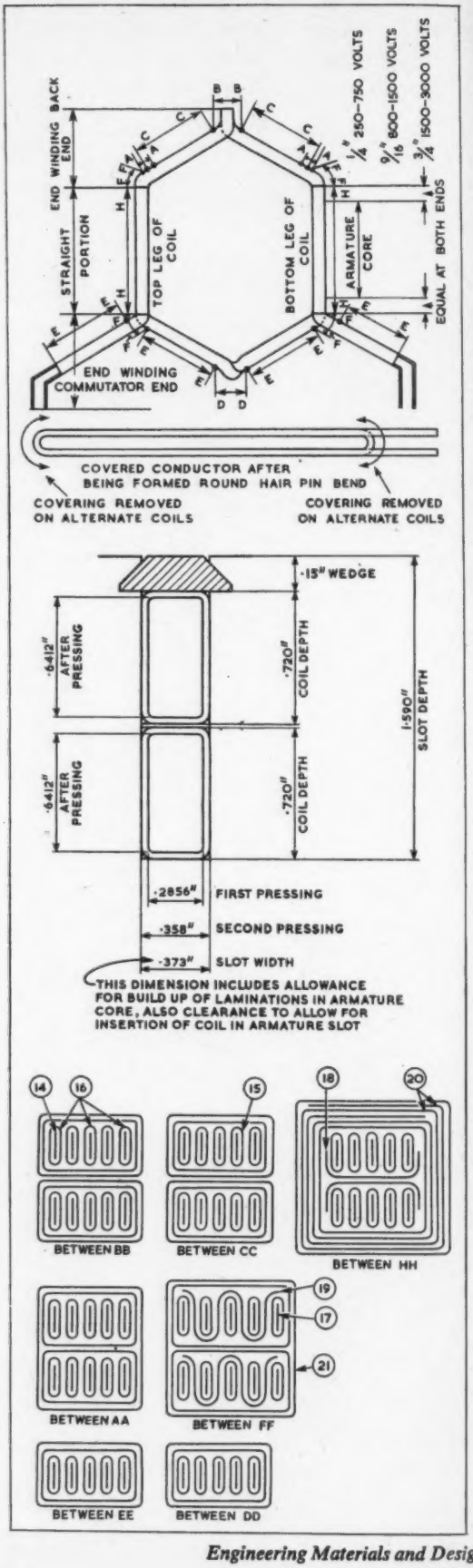
4 × 0·008	= 0·0320	**17**
4 × 0·0065	= 0·0260	**20**
2 × 0·007	= 0·0140	**21**
	0·3576	(say 0·358 coil width).

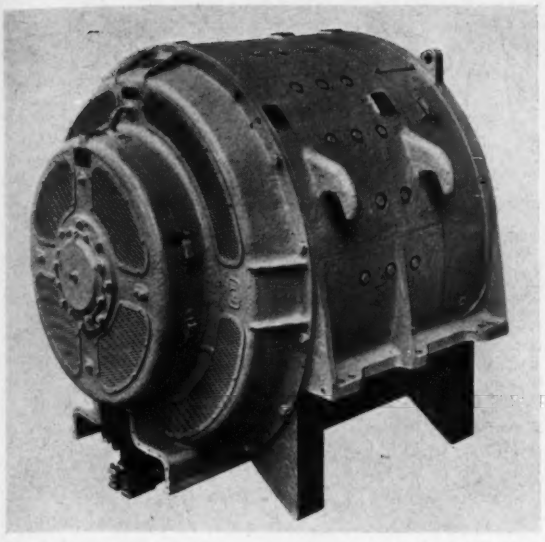
Slot Depth—

0·150	armature slot wedge.
0·720	coil depth, top leg.
0·720	coil depth, bottom leg.
1·590	

Slot Width—

0·358	coil width.
0·010	build up of armature laminations.
0·005	clearance.
0·373	





Crompton Parkinson type CG 426 1,530-kW. main generator with Class F insulation, for British Railways.

copper section, and to facilitate forming to shape it is advisable to employ smaller sections of copper and build up the required sectional area. After forming, the coils should be wrapped from end to end with specially woven glass tape (0·003 in.) which has previously been impregnated in a high-grade baking varnish. Insulation to earth is applied to the straight portion, and it should project at least $\frac{1}{16}$ in. beyond each end of the main pole body. The insulation should be not less than two wrappings of three-layer mica splittings bonded with shellac, in conjunction with at least two wrappings of Melinex. The coil is finally covered from end to end with butt-jointed unimpregnated asbestos tape, and brushed with hard-setting phenolic varnish. After air drying for 5 hr., the straight portion of the coil is pressed in blocks which have been preheated to 170 deg. C. The materials used should be calculated on the basis of 1 per cent compression.

General Notes on Shunt Windings

In main generators on diesel-electric locomotives it is usual for the field system to have two shunt windings, one of which carries a much higher current than the other and must therefore be of a larger cross-sectional area. In this case it is desirable to use a rectangular-section conductor of equivalent sectional area, since a better space factor is achieved. Wherever possible, windings of copper strip should be used, but in order to take full advantage of this construction it is essential to have a coil of even tiers. This means mounting the coil in a position on the main pole body remote from the magnet frame, otherwise a coil of uneven tiers is necessary to conform to the inner face of the magnet. The design and manufacture of strip shunt coils should follow the same procedure described for series coils, using the same amount and type of insulation.

Connectors

Before commencing the winding operation, a soft double annealed copper lead to the terminal is soldered to the starting end of the conductor, using a high melting point solder. The connector is insulated with a half lap layer of glass and mica combination which has been cut from sheets built up of two layers of mica splittings, the layers being bonded with clear extra-flexible varnish, and protected on both sides with woven glass cloth of 0·002 in. nominal thickness. The terminal strip at the end of the winding is insulated in a similar manner.

Armature Coils

The armature coil conductors are insulated, after forming to shape, with 0·003-in. woven glass tape impregnated in baking varnish. The taping is applied $\frac{1}{4}$ lap (just overlapping) to each bare conductor from end to end of the coil. Separators are cut from the special epoxy varnished glass cloth previously mentioned, and are inserted between the conductors at the evolute, where they have been formed round a 180° bend. They are cut into a U shape, and should extend the full depth of the top and bottom legs of the coil. In order to avoid displacement of assembled insulated conductors during subsequent operations, it is advisable to apply a permanent spiral wrap of $\frac{1}{4}$ in. × 0·003 in. woven glass tape from end to end of the coil.

The production schedule should then be as follows:

1. Temporary taping of cotton impregnated in paraffin wax is applied butt joint from end to end of the coil.
2. The first pressing of the straight portion of the coil is carried out in pre-heated mild-steel blocks at 180 deg. C.
3. The temporary wrapping is removed, and the coils wrapped from end to end with a half lap $\frac{1}{4}$ in. × 0·003 in. glass tape impregnated in baking varnish.
4. Main insulation to earth is applied along the straight portions:
   up to 750 V.—one wrapping of three-layer mica splittings bonded with shellac, with one wrapping of Melinex (0·001 in.)
   800 to 1,500 V.—two wrappings ditto
   above 1,500 V.—minimum of three wrappings ditto
5. The coils are now covered with a butt-jointed $\frac{1}{4}$ in. × 0·007 in. special glass tape impregnated in varnish.
6. The straight portion of the coils is brushed with hard-setting phenolic varnish.
7. After drying at 110 deg. C. for 2 hr. the coils are given the second pressing, which brings them to final size. The pressing blocks are preheated to 180 deg. C.

To accommodate a pressed coil, the slots in the armature core should be manufactured to tolerances −0·000 in., +0·004 in. in depth, and −0·000 in., +0·003 in. in width.

Two-turn Armature Coils

For two-turn armature coils, the conductor has a semi-circular edge and is insulated with glass fibre lapping. The forming operation, which involves a 180° bend round pins, may damage the insulation, and therefore on alternate coils the insulation is removed and replaced by a half lap application of special glass tape 0·003 in. thick. The outer conductors on each coil should have the covering replaced in this way. After forming, a reinforcement of the insulation on alternate inner conductors is applied at the four corners adjacent to the straight portion. This consists of a U-shaped insert made of single-layer mica between two sheets of Melinex 0·001 in. thick. The straight portion is brushed with hard-setting phenolic varnish and allowed to dry. Melinex 0·003-in.-thick separators are inserted between turns along the straight portion, and extending slightly beyond it. From here on the coil is similar to a single-turn coil in the production schedule.

Multi-turn armature coils are made from round copper wire, but as the wire must withstand considerable abrasion during the manufacture of the armature, it is recommended that it should be covered with a suitable Class F enamel in addition to two wrappings of glass fibre. After winding on a suitable block and forming to shape, the outer insulation is applied. However, on machines of over 1,000 V., it is advisable to divide the coil into groups insulated from each other by a half-lap application of special glass fibre tape 0·003 in. thick. The tape should be pre-impregnated in baking varnish.

Method for Obtaining Predetermined Dimensions on Multi-turn Armature Coils with Class F Insulation (all dimensions in inches).

Assume 800-1,500 V., six coils per slot, seven turns per coil, with a conductor 0·030 diameter bare Pigenam medium covered and double glass covered to 0·0404 overall diameter.

22. covered conductors.
23. 0·003 treated woven glass tape (machines above 1,000 V.).
24. wrappings along straight portion.
25. 0·003 treated woven glass tape.
26. 0·007 treated woven glass tape.

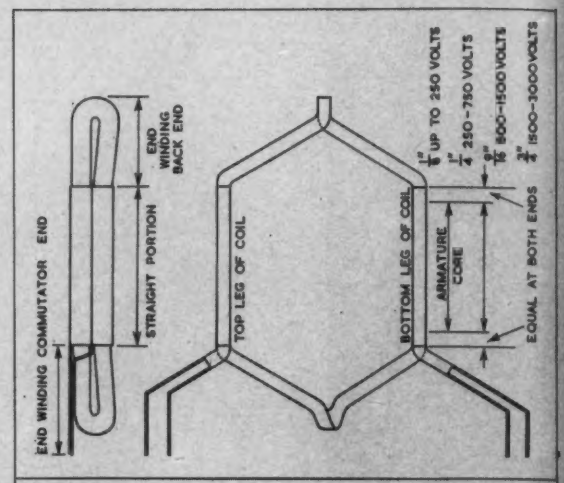
Separate Wrappings in Conjunction with Each Other, **24**—
0·0055 mica and bonding varnish.
0·0010 Melinex.
0·0065

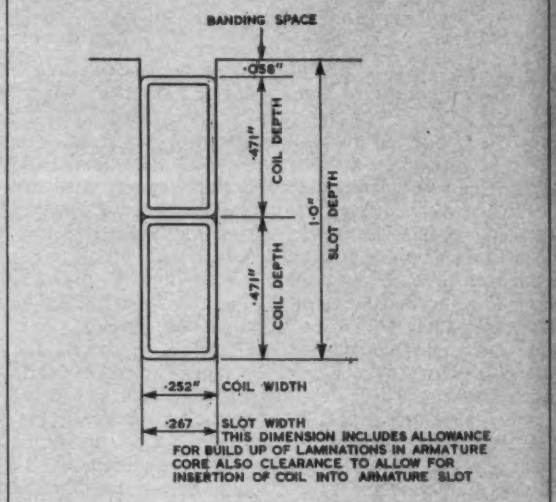
Coil Depth—
1 × 0·3875 = 0·3875 winding space.
4 × 0·0030 = 0·0120 **23**
4 × 0·0030 = 0·0120 **25**
7 × 0·0065 = 0·0455 **24**
2 × 0·0070 = 0·0140 **26**
0·4710

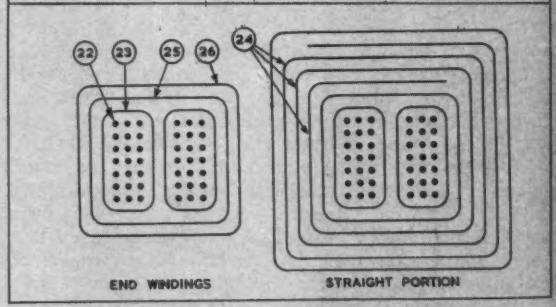
Coil Width—
1 × 0·163 = 0·163 winding space.
8 × 0·003 = 0·024 **23**
4 × 0·003 = 0·012 **25**
6 × 0·0065 = 0·039 **24**
2 × 0·007 = 0·014 **26**
0·252

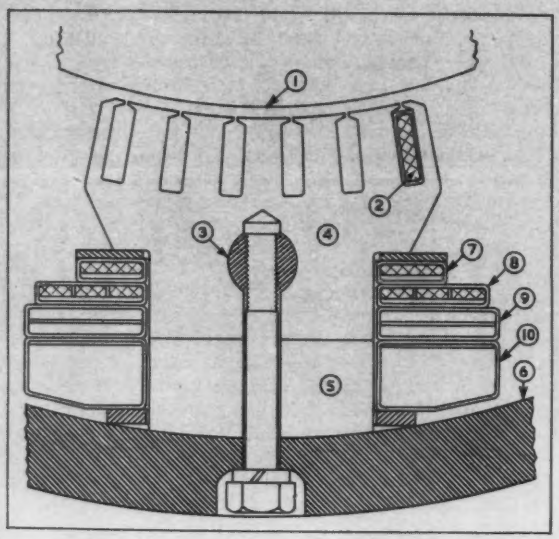
Slot Depth—
0·058 banding space.
0·471 coil depth, top leg.
0·471 coil depth, bottom leg.
1·000

Slot Width—
0·252 coil width.
0·010 build up of armature laminations.
0·005 clearance.
0·267





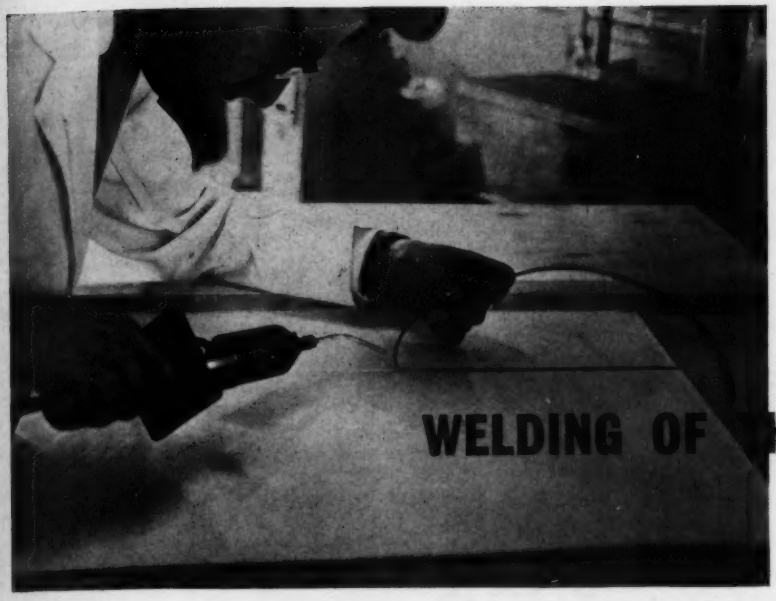




1. ARMATURE
2. COMPENSATING WINDING (CONDUCTOR, HEAVY COPPER SECTION)
3. STEEL INSERT
4. LAMINATED MAIN POLE
5. MAIN POLE BODY (LAMINATED OR STEEL)
6. MAGNET FRAME
7. SERIES WOUND COIL (CONDUCTOR, HEAVY COPPPER SECTION)
8. SERIES WOUND COIL (CONDUCTOR, LIGHTER COPPER SECTION)
9. SHUNT WOUND COIL (BARE COPPER STRIP CONDUCTOR)
10. SHUNT WOUND COIL (DOUBLE GLASS-COVERED ROUND CONDUCTOR)

On the left is a pole construction and field assembly containing separate main field coils, and employing compensating winding as claimed in Patent No. 629,063 (1949).

(To be continued in the April issue.)



A demonstration of welding technique for Propylex, the new polypropylene sheeting produced by British Celanese Ltd.

WELDING OF THERMOPLASTICS

THE Joint Committee on the Welding of Thermoplastic Materials, which is sponsored by the Plastics Institute, The British Plastics Federation and the Institute of Welding, has been examining the existing terms and definitions for the welding of thermoplastic materials. The Committee is of the opinion that some improvement in the definitions is desirable. The Joint Committee will welcome comments on the following recommended terms and definitions; suggestions may be submitted to any of the three sponsors.

Dielectric Welding: see "High Frequency Welding".

Filler Rod: A rod of thermoplastic material used in hot gas welding to provide a source of softened or molten material to fill a welded joint. (BS 1755:1951—No. 7605.)

Flame Sealing: A welding process in which the surfaces to be united are softened by the heat of a flame.

Friction Welding: A pressure welding process in which the surfaces to be united are softened by heat generated by friction. (BS 1755:1951—No. 7611.)

Heat Sealing: A term applied particularly in the packaging industry to the welding of thin thermoplastic materials (generally below 0·020 in.).

Heated Tool Welding: "Radiant Heat Sealing" and "Radiant Heat Welding". A pressure welding process in which the surfaces to be united are softened by conduction or radiation of heat from heated tools.

High Frequency Welding: "Dielectric Welding". A pressure welding process in which the surfaces to be united are softened by heat produced by a high-frequency field. (BS 1755:1951—No. 7602.)

Hot Gas Welding: A pressure welding process in which the surfaces to be united are softened by a jet of hot air or inert-gas produced by a welding torch. (BS 1755:1951—No. 7603.)

Impulse Sealing: A pressure welding process in which the surfaces to be united are subjected to rapid heating followed by cooling, pressure being maintained over the whole of the cycle.

Induction Welding: A welding process in which the surfaces to be united are softened or melted by heat transferred from an electrical conductor which is embedded in the thermoplastic and is itself heated by currents induced in it by an alternating magnetic field.

Molten Bead Sealing: A welding process in which the thermoplastic material at the joint is melted by the extrusion of molten beads on top of two overlapping sheets.

Pressure Welding: Any welding process in which the weld is made by sustained pressure while the surfaces to be united are in a softened condition. (BS 499:1952—No. 2401.)

Radiant Heat Sealing: See "Heated Tool Welding".

Radiant Heat Welding: See "Heated Tool Welding".

Seam Welding: (including continuous and intermittent heating processes): A pressure welding process which forms a continuous welded seam in which the surfaces to be united are softened either by heat produced by a high-frequency field or by conduction of heat from heated rollers or bars. The pressure may be applied continuously by rollers or progressively, as in stitch welding. (BS 2759:1956—No. 427; and BS 1755:1951—No. 7608.)

Spot Welding: A pressure welding process in which a relatively small area of the surfaces to be united is softened either by heat produced by a high frequency field or by conduction of heat from heated electrodes. (BS 2759:1956—No. 428; and BS 1755:1951—No. 7610.)

Stitch Welding: A pressure welding process in which the surfaces to be united are softened either by heat produced by a high-frequency field or by conduction of heat from heated tools. The pressure is applied progressively along the joint by two mechanically operated metal fixtures. (BS 1755:1951—No. 7607.) (N.B. This definition does not include high-frequency welding with patterned electrodes simulating stitch markings.)

Ultrasonic Welding: A friction welding process in which the friction is intermolecular and is set up by ultrasonic vibration.

Welding Torch: A device used in hot gas welding to heat air or an inert-gas and to direct it in the form of a jet on to the area to be welded. The gas may be heated electrically or by passing it through a tube heated by a gas flame. (BS 1755:1951—No. 7604.)

Note: The term "sealing" is currently used and appears in the above terminology. In every case above, it means welding, and the Joint Committee recommends that the elimination of this unsatisfactory term be considered.

THE HARMONIC DRIVE: PART 2

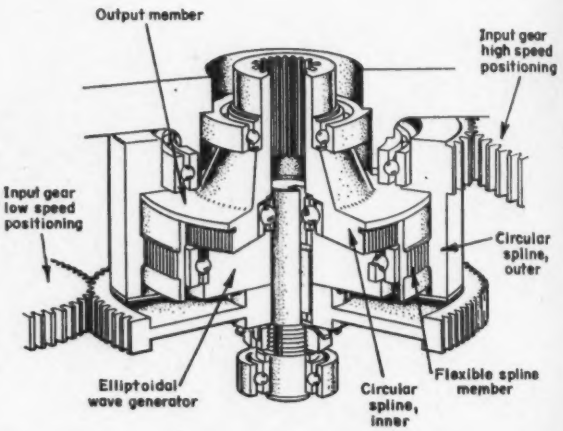
The basic principles of the harmonic drive were dealt with in detail in the February issue. This concluding section illustrates the great variety of potential applications for this device

by C. W. MUSSER

Fine/Coarse Control Drive

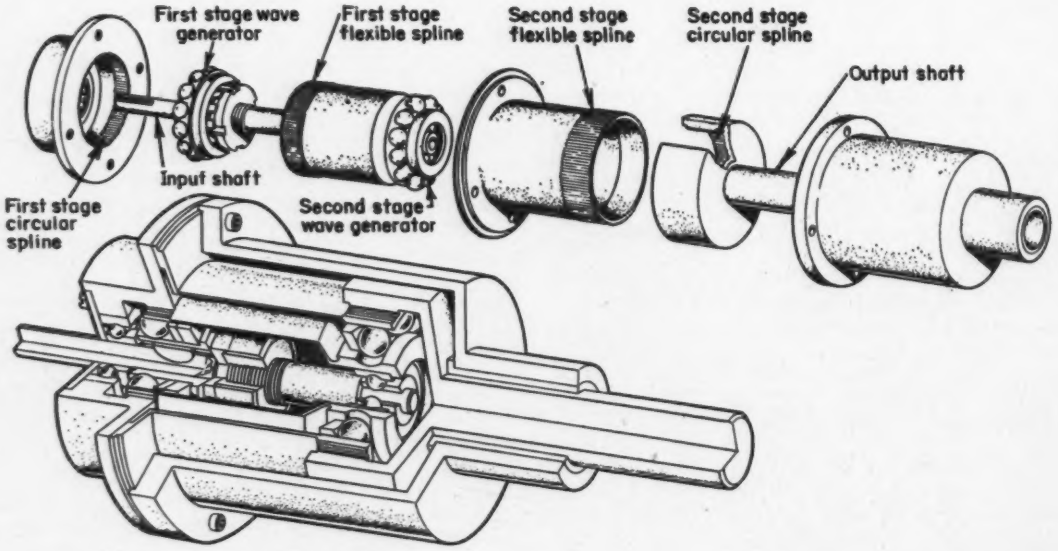
Independent low-speed and high-speed positioning controls are achieved in a dual-stage drive system. The input gear at the left drives an elliptoidal wave generator which deflects a flexible spline member. The external spline engages the outer circular spline at the major axis; the internal spline engages the inner circular spline at the minor axis. Through dual action, the input rotation is reduced by 30:1 in the assembly.

For fast positioning, input rotation is introduced at the outer circular spline by means of the gear at the right. A slight speed increase is produced through dual-stage action of the splines.



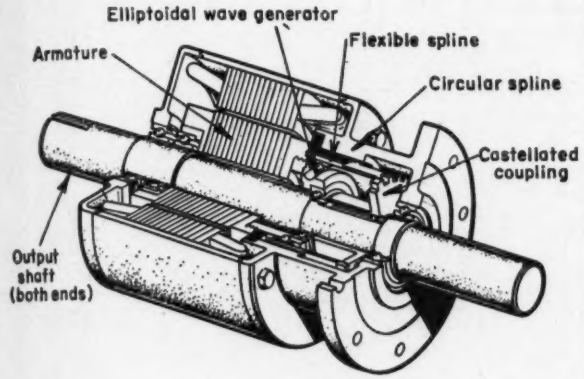
Compound High-ratio Reducer

A two-stage drive system provides a reduction ratio that is the product of separate stage ratios, and which can range from 2,500:1 to 200,000:1 depending on design. The input shaft drives an internal first-stage wave generator which deflects a flexible spline to engage a circular spline in a stationary housing. Clockwise rotation of a wave generator produces reduced counterclockwise rotation of a flexible spline which is coupled directly to an internal second-stage wave generator. The second-stage flexible spline is secured rotationally to the housing. Counterclockwise rotation of the second-stage wave generator produces reduced counterclockwise rotation of the second-stage circular spline, which is coupled directly to the output shaft.



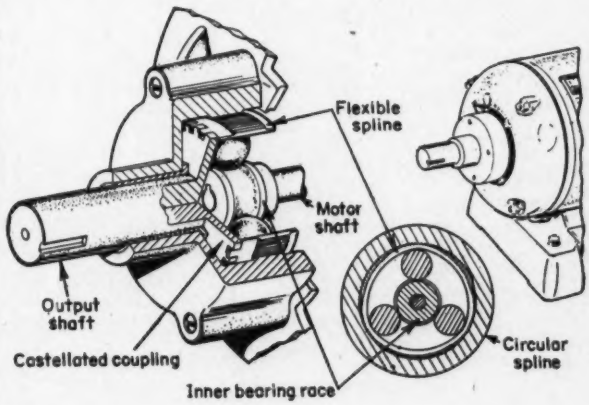
Through-shaft Motor-reducer

A single-stage system permits axial through-shaft design for low-speed, high-torque output at both ends of the unit. A rotating armature is coupled to an elliptoidal wave generator which deflects a flexible spline into engagement with a circular spline. The circular spline is integral with the drive housing. The output shaft is joined to the flexible spline by a castellated coupling.



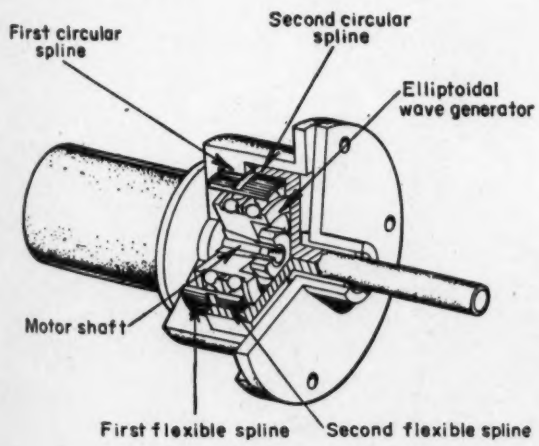
General-duty Motor-reducer

A minor modification of a commercial motor incorporates a 264:1 single-stage reduction system in an end-bell. A motor shaft drives an inner bearing race and a three-ball planetary wave generator, producing a symmetrical three-lobe deflection wave. A flexible spline with 240 teeth is deflected into a 243-tooth circular spline in three regions. A rolling-ball reduction of 3·3:1 combines with an 80:1 spline ratio to produce an overall 264:1 ratio.



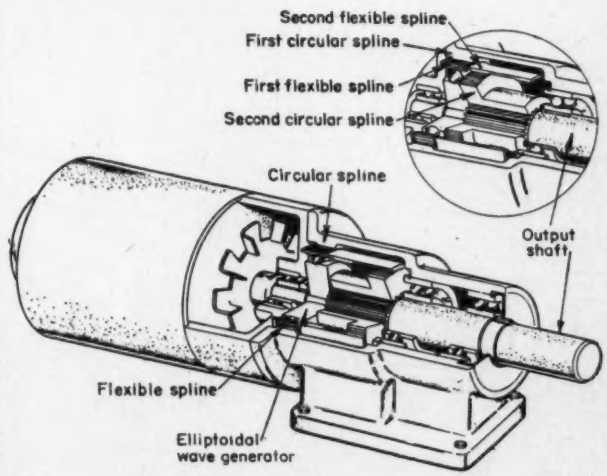
Dual-stage Reduction Drive

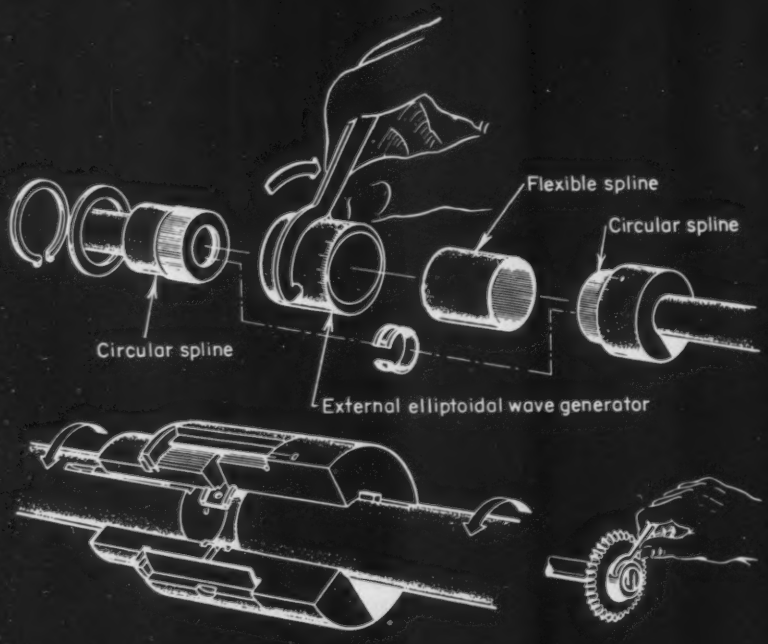
A reduction ratio of 12,880:1 is produced by a compact dual-stage drive arrangement. A motor output shaft drives an elliptoidal wave generator, deflecting a flexible double-spline element so that the first flexible spline (160 teeth) engages the first circular spline (162 teeth), and the second flexible spline (159 teeth) engages the second circular spline (161 teeth). The two sets of splines have slightly different ratios of opposite algebraic sign, producing a differential action with high speed reduction.

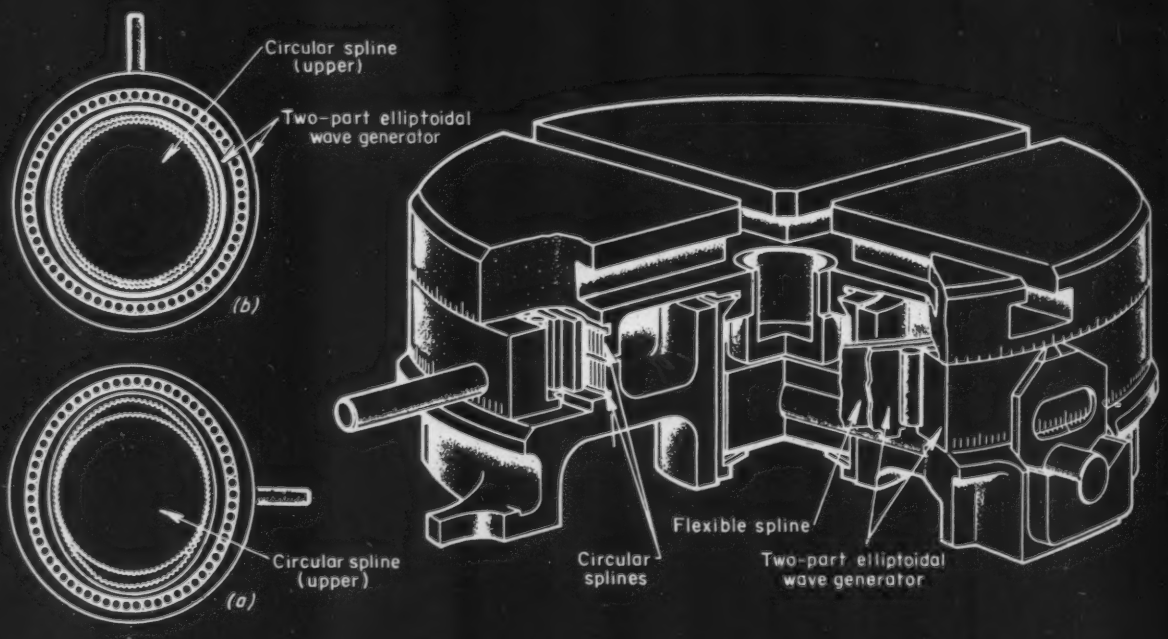


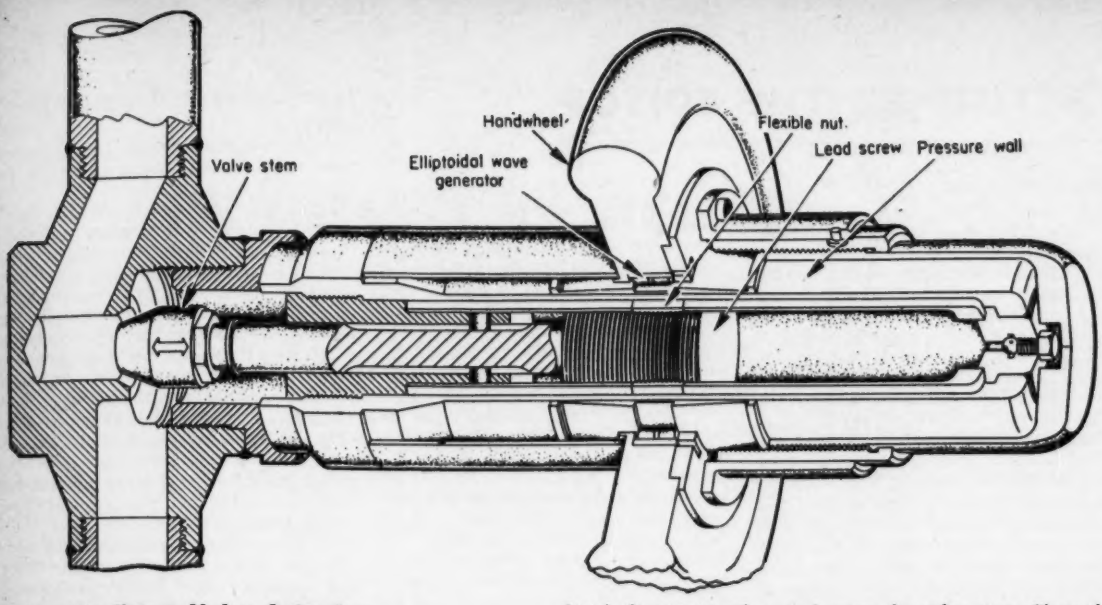
Modular Design Motor-reducer

A single-stage 40:1 reducer system is changed to an 800:1 reduction dual drive by reversing the assembly position of a circular spline. The full drawing shows single-stage drive, with reduction ratio determined by an internal circular spline and an external spline at the left end of the flexible multiple-spline element. The engagement at the right end is that of a conventional spline. Inset shows an output circular spline reversed to mesh with an internal elliptoidal spline, forming an intermediate-ratio dual drive with an 800:1 reduction.




Flexible spline
Circular spline
Circular spline
External elliptoidal wave generator


Circular spline (upper)
Two-part elliptoidal wave generator
(b)
(a)
Circular spline (upper)
Flexible spline
Circular splines
Two-part elliptoidal wave generator

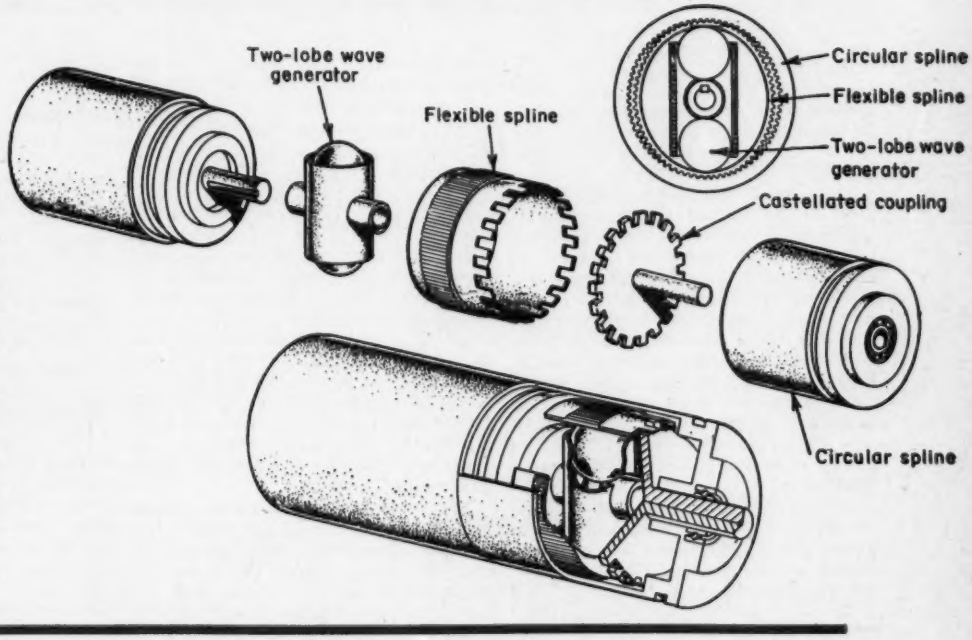


Rotary-to-linear Valve Actuator

A modified drive system for the conversion of rotary-to-linear motion is used to actuate a sealed valve-stem assembly. A hand wheel rotates a wave generator which transmits its elliptoidal shape through a sealed pressure wall to a flexible nut. A lead screw is held from rotating by pins, but is free to translate and move the valve stem. Since the lead screw has double-lead threads, the two-lobe wave generator deflects the zero-lead flexible nut into engagement on the minor axis. As the wave generator rotates, the regions of thread engagement advance around the periphery of the lead screw, producing translation of screw and valve stem.

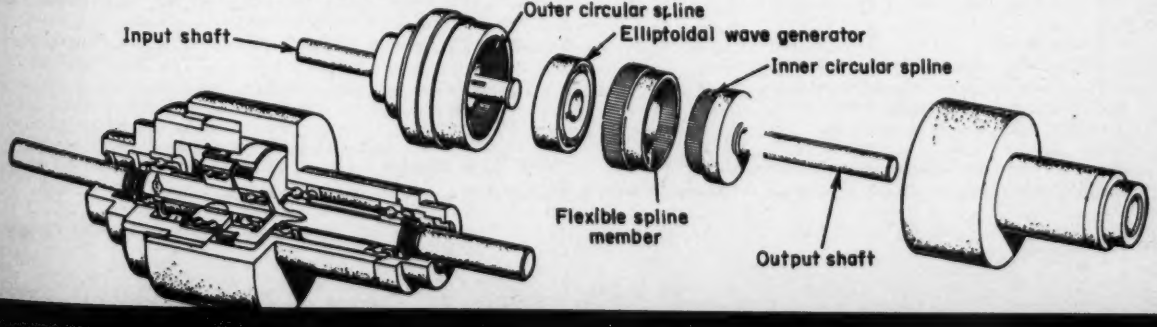
Instrument Motor-reducer

A single-stage drive system uses a two-lobe wave generator to provide a 350:1 reduction in a short extension of a miniature instrument motor case. A motor shaft drives a small inner bearing race and two balls to deflect a flexible spline into engagement with a circular spline fixed to the case. A castellated coupling joins the flexible spline to the output shaft. A rolling-ball reduction of 5:1 combines with a 70:1 spline ratio to produce a 350:1 reduction.



Intermediate-ratio Dual-reduction Drive

A dual-reduction drive system employs a single wave generator to produce tooth engagement at the major and minor axes of an elliptoid. An external flexible spline (124 teeth) engages an outer circular spline (126 teeth), and an internal flexible spline (116 teeth) engages an inner circular spline (114 teeth). The ratios of the two sets of splines have the same algebraic sign, resulting in an approximate 30:1 reduction.



LETTERS TO THE EDITOR

Design Diploma

Sir,

The two letters on the Design Diploma which appeared in the January issue (p. 40) were most interesting. Before making reference to these letters, I should like to outline some recent developments which have modified the original proposals.

It is now thought that the Diploma of Design courses could be presented at evening classes, and could include, as originally proposed, the project designing exercises, provided the principle of "continuous courses" was adopted. This means that the student would set his own pace, completing his projects in the best possible time. For the mature student with many home commitments, attendance at the courses would be subject to a minimum requirement (say one evening per week). If the student had not completed the requisite number of projects prior to the examination, he would remain in the course until the next examination, these being held at regular intervals of possibly twice per year. All students would be entered for the examinations by the course lecturers when their work had reached a required standard, and the minimum number of course projects, technical reports and theses, submitted. The object of the course is not to produce "Diploma-ists", but competent designers for industry. Time is less important than the attainment of a high standard, to meet the present-day needs of industry.

DESIGNER'S NEEDS OVERLOOKED

There seems little doubt that the real needs of the designer are overlooked in the present available courses at colleges. Generally, such courses are intended to meet the needs of the mechanical engineer, *not* the design engineer. It is "false economy" to make the mechanical engineering course serve the needs of both mechanical *and* design engineers, when it is obvious that the designer requires training far in advance of the existing courses. Employers realise this, and seldom advertise for designers of H.N.C. calibre unless supported by several years' "experience".

It is logical, therefore, that the existing courses would form a background to the Project Designing Course, and for those already holding National Certificates the following suggestions are made.

The Diploma Honours course (Dip. Des. (Hons.)) should be available to those holding H.N.C. or equivalent, while the Ordinary Diploma course (Dip. Des.) is provided for holders of O.N.C. or equivalent. The attainment of the ordinary diploma would serve as an entrance qualification for the Honours course.

To cater for the group of draughtsmen who have neither O.N.C. nor H.N.C., a comprehensive course is envisaged leading to the ordinary Diploma. Such a course would include the background subjects, mathematics, mechanics, strength of materials, and theory of machines. The whole course would be graded into "stages", and the "continuous course" principle would still apply. Project design would be the principal subject at all stages. Examination would be in project design only. The accompanying thesis would be expected to contain the student's mathematical approach to the solution of the problem, and would be assessed on its presentation and theoretical content. As well as the thesis, the detailing of the candidate's project would be an essential part of the examination, while the oral examination would become obligatory.

In the assessment of a candidate's work, it is thought that the following should be taken into account. The scheme produced in the examination, the detailing and the thesis (post-examination requirements) and the oral examination, would each receive assessed marking. The student's course work projects, technical reports and thesis should also be taken into account in the assessment, together with employer's and lecturer's references.

Detailed proposals for a method of assessing examination results to maintain a national standard have been put forward, and are to be incorporated in the programme for the Diploma of Engineering Design Technical Committee.

A series of "change-over" courses is also visualised, to help the designer wishing to move from one branch of engineering to another. Such courses would be devised so that the candidate did not require to be re-examined in subjects for which he already held certificates.

It is further proposed that there should be available to every candidate for the examination a "Designer's Handbook" containing brief notes on design criteria, together with a "Handbook of Standards, Standard Components and Equipment". These books have to be specially edited for the course, and have been included in the proposals for the Technical Committee of the Diploma Organisation.

It will be seen from the foregoing that the award of a Diploma is not dependent upon one examination only, as was suggested by "M.I.Mech.E." in his letter, and neither would it become "just one more diploma for the drawer", although I do agree with the correspondent in calling such people "inventors".

The suggestion that designers should devote their leisure to the study of a foreign language does not seem entirely relevant. I would suggest that a creative art would be more in keeping with the kind of talent a designer should develop.

Mr. G. T. Schwartz expresses the hope that the courses would be specialised. It is felt that over-specialisation would be a mistake, and that in general the courses should cover a wide field, with projects ranging from the simple mechanism to the complex assembly (from the pressure gauge to the excavator, to use Mr. Schwartz's example). This principle should lead to adaptability. Regarding "notes being available during examinations", the "Designer's Handbook" mentioned above should ease the burden on the candidate's memory.

W. A. A. Witham
4 Kennel Lane, Bracknell, Berks.

Information for Engineers

Sir,

Last month's issue (p. 115) contained two letters commenting on my article "Information for Engineers".

I will not take up all Mr. W. D. Arnot's points, some of which suggest misunderstanding. For instance, the article did not refer to information officers, and I hold no brief for the way they are recruited at present; it did suggest that special steps should be taken to determine the names deserving early study in any particular field; and it did not imply that P.E.R.A. dispenses photocopies to all comers.

I would, with the greatest respect, refer Mr. Arnot back to my text and, since he mentioned it, to my letter in *Engineering* of September 23 last. My position is that I have observed that many engineers have poor technical information, and I described practical arrangements that many people could make at once to have better. Of course, it would be better still if each engineer had time to look after his own information properly, or had the services of someone "with very wide industrial experience . . . and a knowledge of several significant languages". But few have time or the assistance of such a man, and I therefore recommend the not uncommon practice of reducing the work as far as possible to a system and delegating it, because this reduces the load on the engineer and produces a specialist in at least some small part of the business of knowing where to find information.

I am sorry for my error in the publication frequency of *British Chemical Plant*. Mr. J. L. Good can hardly object to its being described as a summary, though. It summarises information about part of an important industry, and it well illustrates the type of useful publication which a specialist comes to know of, but which the unassisted engineer in a different technology would have to search for.

Research Laboratories,
D. Napier & Son Ltd.,
Acton,
London, W.3.

College of Aeronautics

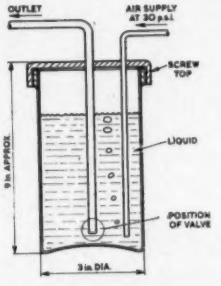
The Governors of the College of Aeronautics have decided to change the titles of three of the College's teaching departments. The Department of Aircraft Economics and Production is to be renamed the Department of Production and Industrial Administration; the Department of Aircraft Electrical Engineering is to be called the Department of Electrical and Control Engineering; and the Department of Aircraft Materials is to be the Department of Materials.

These new titles will be introduced into the College publications and records during the current academic year, so that they will become finally established by the beginning of the next session, in October 1961.

Since 1959 the College has been pursuing a policy of diversification of teaching activities, and as a result a number of new advanced courses have been developed in subjects which, although relevant to aeronautics, are of equal interest and value to many other branches of engineering.

PROBLEMS IN DESIGN

Problem No. 13 (November): A piece of medical apparatus embodies a liquid container (shown diagrammatically) which is pressurised with air at 30 p.s.i. Both the inlet pipe from the air supply and the outlet pipe for carrying the liquid are of stainless steel. The problem is to design a valve to enable the liquid to be drawn off at will. Since the liquid is a slurry, which is liable to dry and set into a hard abrasive solid, no ordinary on-off gate valve can be used; the entire bore of the pipe, including the flexible portion to the instrument, must remain unconstricted



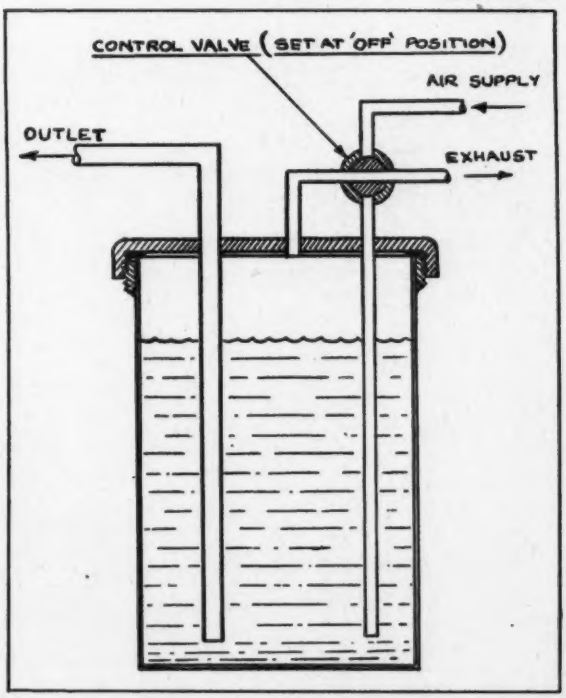
and smooth. It is necessary to incorporate a valve, operated either by a solenoid air valve or by a mechanical air valve controlled remotely by Bowden cable, which would (a) open the end of the outlet pipe under the liquid, and (b) simultaneously allow a small flow of air through the liquid to keep the slurry in suspension while the valve is open. As the container has to be removed for refilling, no great modification is permissible. The screw top, however, can be redesigned as a casting to incorporate the operating device.

Problem No. 13 represents a considerable departure from those which have appeared in other issues. It is highly specialised, concerns a particular product, and calls for inventive ability. To present an elegant solution meant much more than merely making a rough sketch, and we were gratified by the number and variety of the entries. We noticed that some of the best of these came from readers who have already submitted good entries to problems of an entirely different kind appearing in previous issues.

The various entries can be divided into two main groups: (1) those in which the liquid flow is controlled by the incoming air supply, and (2) those in which the liquid flow is controlled on the outlet side. **G. E. Ives'** entry comes in the first category, and he has chosen to eliminate any valve mechanism in the abrasive liquid by connecting an air relief valve between the screw top of the container and one port of a four-way cock in the air inlet line. In the "On" position the air pressure is transmited to the container, and in the "Off" position the air supply is cut off and the relief line opened to atmosphere. The valve, he explains, could be of a rotary or piston type. The advantage of this design lies in the fact that agitation could take place with no flow. The apparent disadvantage is that it would be necessary to wait a little for pressure to build up in the vessel for flow to be at its maximum. The response rate would therefore be slow.

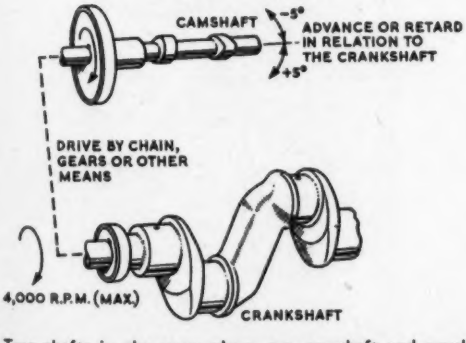
J. Lampard chooses a simple cable-operated plunger valve to control the outgoing liquid. This valve controls the incoming pressurising air, so the solution also comes in the first category. The proximity of the air inlet to the fluid outlet would, we feel, entail a risk that, on the admission of air, unemulsified sediment might block the outlet pipe. Here,

G. E. IVES



PROBLEM IN DESIGN NO. 17

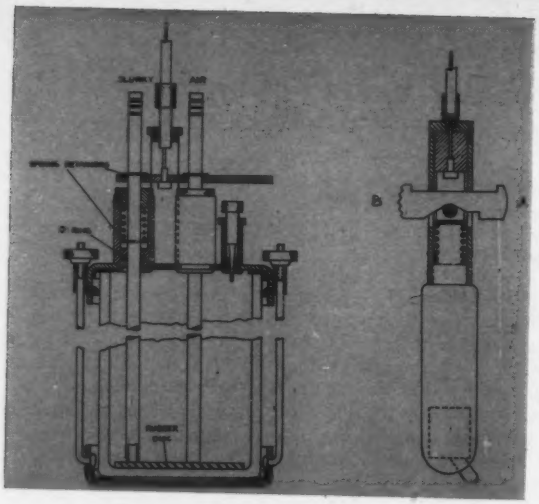
Here is this month's problem



Two shafts in the same plane, e.g. camshaft and crankshaft, are coupled by chain, gears, or other means to provide a fully reversible drive.

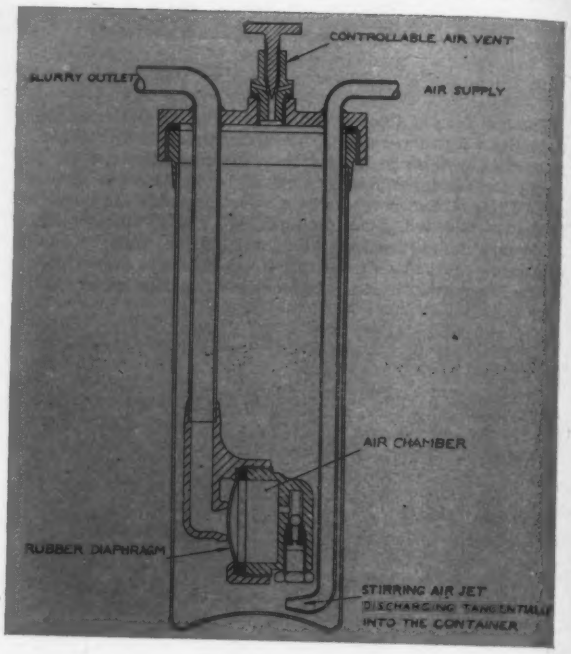
It is desired to alter the phasing of the camshaft and crankshaft by ±5° (a total of 10° movement) while the shafts are in motion. Assume the drive transmitted to be approximately 4 b.h.p., and the maximum speed of the drive shaft to be 4,000 r.p.m.

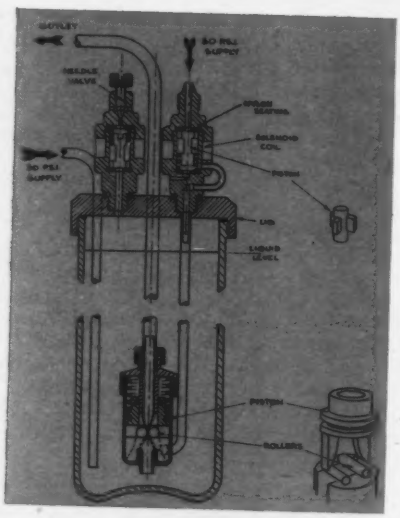
Best solutions to "Problems in Design" are published and paid for. Send your solution for this month, with a drawing or diagram (in Indian ink and not more than 12 × 12 in., please!), to the Editor, "Problems in Design No. 17 (March)". Closing date April 20.



W. BROWN

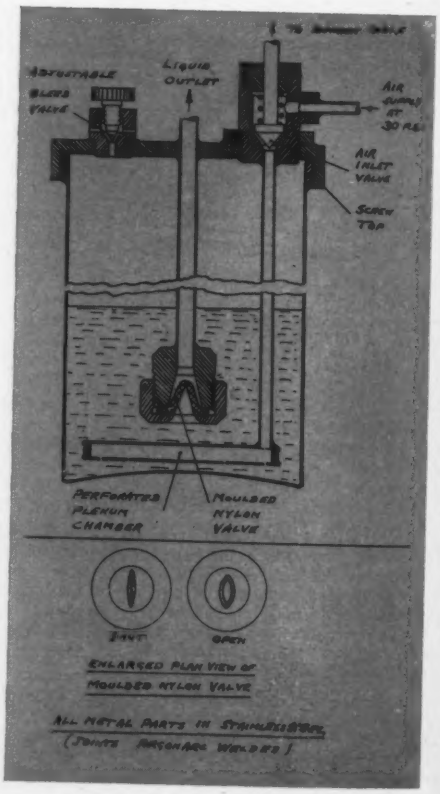
D. C. WOOD

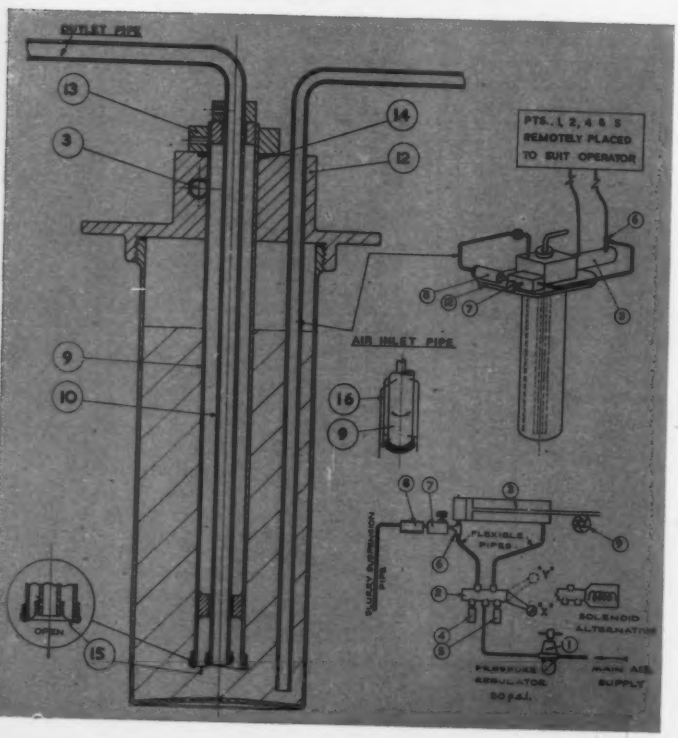




A. MERRY

H. T. E. HONE





W. DOUGLASS

again, there would be some delay before flow reached its maximum.

H. T. E. Hone's entry, also in the first category, is better in that he obviates the need for anti-abrasive seals by putting his air needle-valve in the cover away from the liquid. In addition, he provides an essential feature, namely an adjustable air bleed valve to ensure continuous agitation of the slurry even when none is being run off. The bleed valve is so adjusted that at a certain critical opening of the cable-operated inlet valve, a moulded nylon valve, of a type similar to those now used to replace defective mitral valves in the human heart, breaks open and releases the liquid to the outlet pipe. The perforated plenum chamber, with downward-facing holes, is a good feature. Effectiveness would entirely depend on how well the nylon mitral valve operated in practice.

D. C. Wood's entry is in both categories, and has points in common with the above. Although control is from the air inlet side, a type of balanced pressure valve having a rubber diaphragm is employed. Compressed air is allowed to flow into the container from the supply by a valve of unspecified type. A needle-valve allows agitation to take place. The slurry outlet is closed by a rubber diaphragm held against it by the pressure of a volume of air trapped behind it. As soon as the pressure in the container is sufficient to overcome the pressure closing the diaphragm, this opens suddenly, assisted by the fact that the central portion of the diaphragm, in addition to the annular part around the outlet pipe, is then exposed to liquid pressure. It might have been better to employ a lightly spring-loaded diaphragm. Alternatively, the outlet pipe might be downward facing, closing against a stationary pad on the bottom of the vessel. Excess pressure could be made to raise the outlet pipe by means of a spring-loaded diaphragm in the cover through which it would pass.

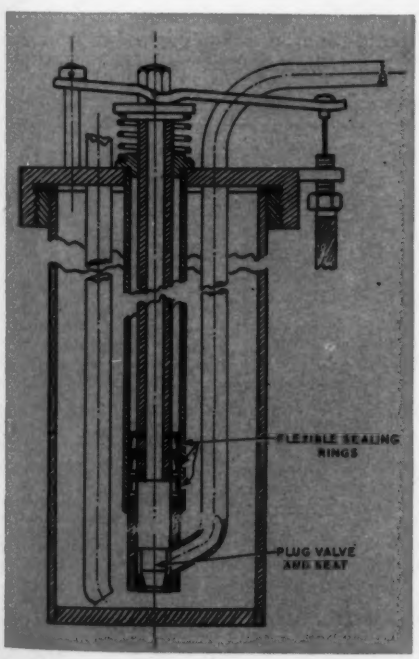
An air-operated solution of some complexity, coming in the second category, from **W. Douglass**, employs a valve principle seen in the Mucon valve. A rack, cut in the piston rod of an air cylinder, causes a spur gear mounted on the outer of two coaxial tubes to rotate through approximately 180° and so cause constriction of an iris diaphragm. The diaphragm is formed by a rubber sleeve fixed to both inner and outer tubes. This solution is ingenious, but we consider that the whole arrangement would be better suited to an apparatus of much larger size. An agitator air bleed would have improved the design.

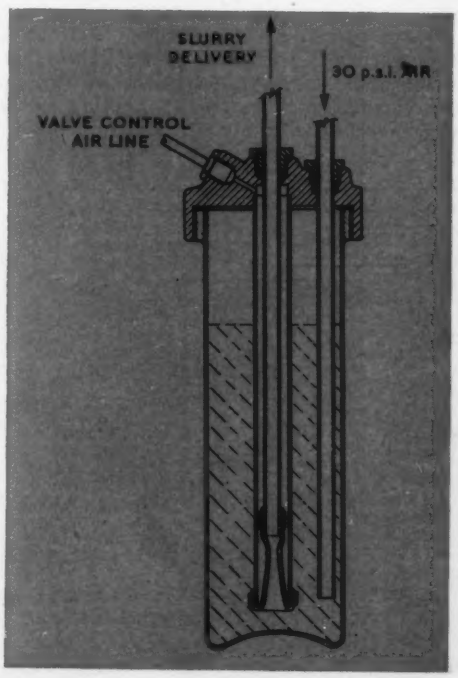
An ingenious air-operated valve which would pinch a rubber or neoprene tube is the main feature of the entry from **A. Merry.** Normally maintained closed by a coil spring and rollers, on air being supplied to the underside of the piston by a solenoid air valve, the pressure on the sides of the tube is relieved. A second solenoid valve, simultaneously operated, allows a controlled amount of air to leak from the container. It would be better to provide for independent operation of the solenoid valves, to ensure adequate agitation and pressurising of the slurry before it was drawn off.

W. Brown's solution has the virtue of simplicity. Simultaneous opening of the air inlet and slurry outlet pipes is brought about by raising them simultaneously from a rubber pad against which they are made to bear by spring pressure. This is done by means of a Bowden cable. Once again we consider that the slurry should be fully pressurised before it is drawn off. Mr. Brown illustrates an ingenious pendant-type control for operating the Bowden cable. By depressing the side *A* of the slider, continuous delivery is obtained until interrupted by pressure on *B*, whereas pressure on *B* only gives delivery while the pressure is maintained. Side *B* is serrated for tactile identification. The addition of a solenoid-controlled main air inlet valve, suggested as an addition by Mr. Brown, would greatly improve the design. He shows the position of a switch for controlling it in the handle of the pendant control.

W. S. Spofforth's entry is both simple and elegant. Closure of the neoprene tube is brought about by air at higher pressure than the 30 p.s.i. pressurising the container. Had an air bleed valve been introduced, to ensure good mixing, the requisite pressure differential to control the slurry outlet pinch valve would exist, and would obviate the need for a pressure regulator which is inherent in the design as it stands.

W. S. SPOFFORTH





J. LAMPARD

SURVEY OF HYDRAULIC ACTUATORS

PART 1

Hydraulic actuators offer designers a compact means of remote-controlled operations in many installations. This article indicates various aspects of design, and also lists the principal manufacturers and suppliers

by J. A. COATES

HYDRAULICALLY operated mechanisms are used extensively in modern industry, since this form of installation, in many instances, provides the simplest and most economical solution to a particular design problem when compared with other possible methods.

High force functions in a limited space, together with precise control, are particular attributes of a hydraulic installation. Operations such as pressing, lifting, lowering, rotating, controlling and clamping are common applications throughout industry, and in the machine tool industry hydraulics are applied to lathes, drilling, boring and grinding machines. Rapid development with the aid of hydraulic actuation and control is also apparent in agricultural machinery and road-laying equipment.

Two of the most widely used types of power device in use throughout industry are the linear and rotary actuators, and it will be of value to indicate the various types available to industry today, and to give an introduction to the simple control of actuator speed, direction and effort.

A simple open-type hydraulic circuit, designed to operate a double-acting cylinder, is shown in Fig. 1. In this example hydraulic fluid is drawn from the tank by a constant delivery pump, pressure regulation being effected by a pressure-relief valve set at the required operating pressure, excess oil being by-passed back to the oil tank; this relief valve also serves to safeguard the pump and its driving motor against overloading. It should be noted that, in order to reduce oil flow restriction to a minimum, the pressure-relief valve is mounted clear of the main pressure line. A non-return valve is fitted between the pump and the reversing valve to prevent oil reversal in the pressure line, and consequent release of load at the actuator piston, when the pump is inoperative.

Piston direction is controlled by a four-way reversing valve, Fig. 1a representing the forward stroke, pressure fluid being directed to volume V_1 and thrusting the piston assembly forward, and oil from volume V_2 being returned to the oil tank. Fig. 1b shows the arrangement for the return stroke; pressure fluid is directed by the reversing valve to volume V_2, oil in volume V_1 returning to the tank.

Variation of piston speed is accomplished by a flow control valve in the pressure line which accurately meters the rate of oil flow to either end of the cylinder (alternatively, the flow control valve could be fitted in the return line).

In the closed-circuit type of system, instead of the oil being drawn from the tank, it is drawn directly from the exhausting end of the cylinder and pumped to the opposite end of the cylinder. In this system a make-up line to the

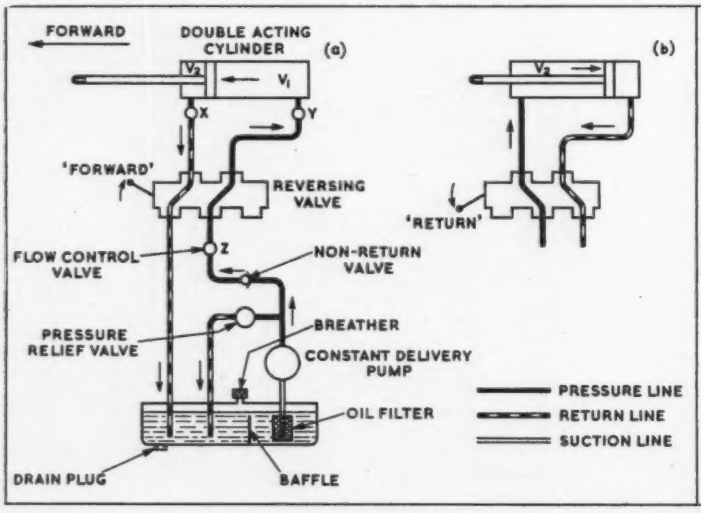


Fig. 1. Open-type hydraulic circuit.

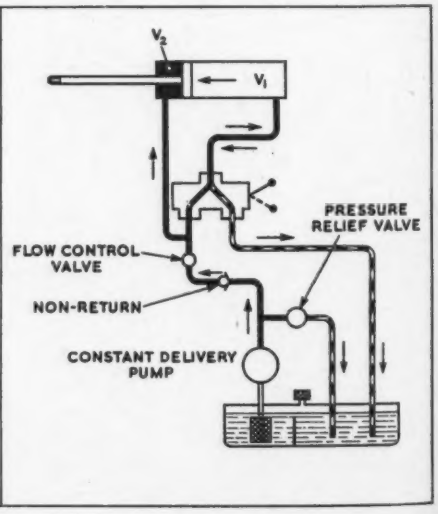


Fig. 2. Closed-type hydraulic circuit.

tank is required in order to replace any oil losses incurred in the circuit; a non-return valve is also required.

The open-circuit system is generally simpler and advantageous in that the flow to and from the relatively large quantity of oil in the tank keeps the temperature in the circuit low.

Piston Speed Control

Referring to Fig. 3, on the forward stroke when $F = 0$, the time required to displace volume $V_1 =$

$$\frac{V_1 \text{ (in.}^3\text{)}}{g_1 \text{ (gal./min.)}}, \text{ or } \frac{A_1 l}{277 g_1} \text{(minutes).}$$

This represents the time to move the piston over stroke l in.

Therefore, the forward piston speed $S_f = \frac{277 g_1}{A_1}$ (in./min.) or $\frac{0{\cdot}385\, g_1}{A_1}$ (ft./sec.). Similarly, for the return stroke $S_r = \frac{277 g_2}{A_2}$, that is if $p_1 = p_2$ and $g_1 = g_2$. The return speed of the piston will vary in the ratio of $\frac{A_1}{A_2}$

This feature can be used to advantage in shortening the cycle times and speeding up work. Considering the circuit in Fig. 1, if it is required to operate with identical forward and return piston speeds, i.e. $A_1 = A_2$, this could be accomplished by fitting a double-ended piston rod, each rod being identical in diameter.

Fig. 2 illustrates a method of obtaining equal piston speeds in either direction with a single piston rod cylinder. In this circuit a constant line pressure is maintained in volume V_2, volume V_1 being open to line pressure for the forward stroke or directed back to oil tank for the return stroke.

For S_f to equal S_r when $g_1 = g_2$ and $p_1 = p_2$,

$$\frac{277 g_1}{A_1} - \frac{277 g_2}{A_2} = \frac{277 g_2}{A_2}.$$

The second part of this equation, i.e. $\frac{-277 g_2}{A_2}$, is the ever-present "effective" aft speed due to the constant delivery being maintained in volume V_2, which will slow the speed in the forward direction by the amount $\frac{277 g_2}{A_2}$, which equals S_r. On the aft stroke no pressure is maintained in volume V_1, the fluid being returned to the oil tank. (The slight pressure due to piston and oil friction is not counted.)

Therefore, for equal piston speeds in either direction, S_f must equal S_r,

$$\text{i.e.} \frac{277 g_1}{A_1} - \frac{277 g_2}{A_2} = \frac{277 g_2}{A_2}.$$

This equation becomes $A_1 - A_2 = A_2$. If $A_1 = 2$ and $A_2 = 1$, then $2 - 1 = 1$.

The above is a mathematical explanation of the 2/1 method of obtaining equal piston speeds in either direction. Thus in this system area A_1 must equal twice the area of A_2, i.e. piston rod area must be half the area of the cylinder.

Independent Speed Control in Both Directions

Independent speed control in both directions can be effected by the use of flow control valves at points X and Y in Fig. 1, both of these valves being arranged to either "meter in" or "meter out" the oil to the cylinder. These valves restrict flow in the one direction only, allowing full bore flow in the reverse direction. Flow control valve Z is omitted in this arrangement.

Alternatively, a two-way flow regulator valve can be fitted at either point X or Y only (valve Z omitted), this valve allowing adjustment of delivery and exhaust rate at one end of the cylinder, thus giving speed control in both directions.

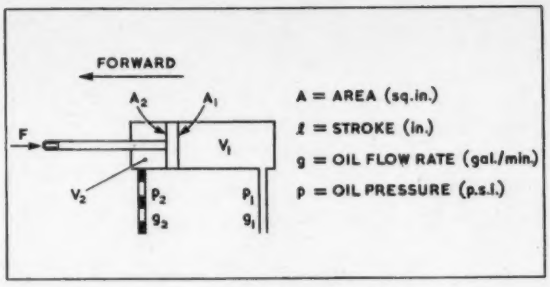


Fig. 3. Piston speed control.

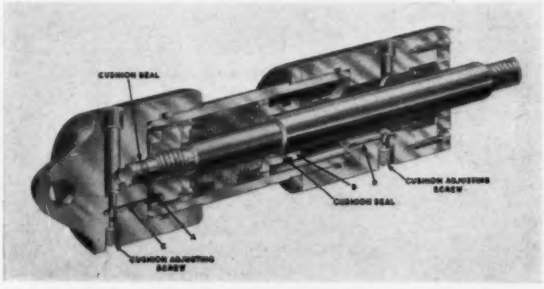


Fig. 4. Section through double-acting cylinder with adjustable cushioning at both ends (H. S. Cattermole & Co. (Hydraulics) Ltd.).

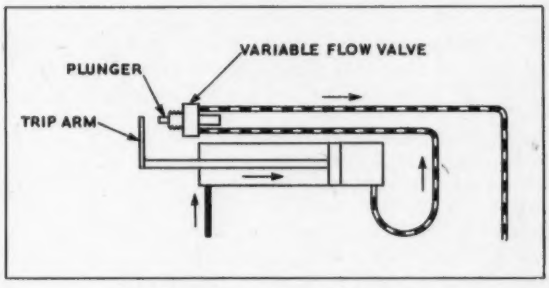


Fig. 5. Cushioning with variable flow valve.

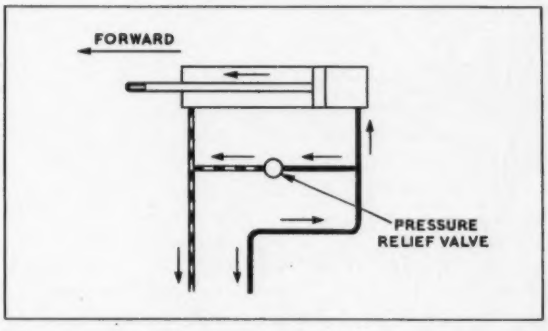


Fig. 6. Pressure limiting valve.

Speed Control via Variable Delivery Pump

Piston speed control can also be effected by controlling the oil supply at the source by using a variable delivery pump, in which arrangement the flow control valve Z (see Fig. 1) can be omitted. This method is advantageous in that less heat is generated than when using a constant

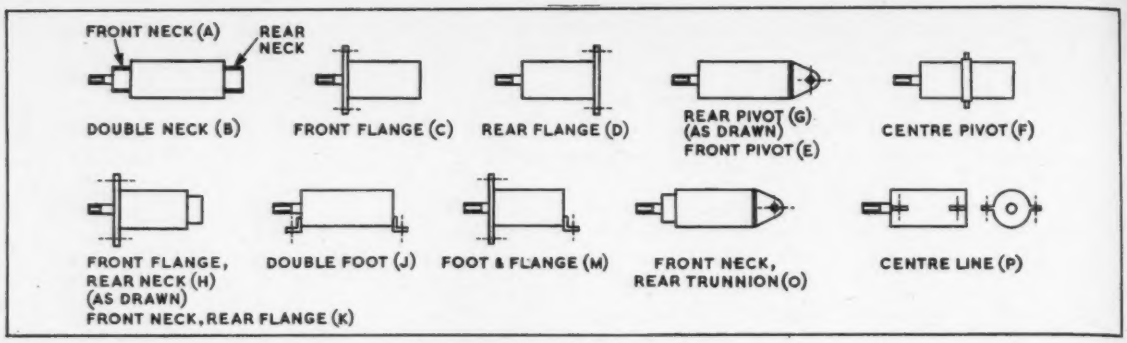


Fig. 7. Types of cylinder mountings.

delivery pump, although constant delivery pumps are generally simpler in construction and consequently less expensive.

Piston Retardation at End of Stroke

Shock loads may be imparted to the cylinder, work piece and surrounding structure, particularly where piston velocity or inertia of connected loads is high. This can be overcome by either incorporating cushioning in the hydraulic cylinder or by fitting a variable flow valve in the relevant pipeline to the cylinder.

Fig. 4 shows a cross-section through a double-acting cylinder, with adjustable cushioning at both ends of stroke. As the piston nears the end of its travel, the cushioning bush *A* or *B* enters its closely-fitting mating bore, blocking off the direct flow to the exhaust port. Fluid is then metered through line *C* or *D* to the exhaust port via the adjustable cushioning screw, thereby cushioning the piston throughout the remainder of the stroke.

A variable flow valve gives change from full bore flow to maximum restriction in the one direction via a plunger movement, whilst allowing full bore flow in the opposite direction at all times. Fig. 5 illustrates the use of a variable flow valve, which in this instance has been arranged to restrict the exhaust side of the return stroke at the end of its travel, hence cushioning the remainder of the travel.

Limitation of Piston Effort

Fig. 6 illustrates a double-acting cylinder with a pressure-relief valve arranged to limit the pressure available for the forward stroke of the piston. The pressure-relief valve by-passes excess oil to the oil tank on the forward stroke, but does not permit a flow in the reverse direction. The return stroke functions as shown in Fig. 1b. This method can be employed to balance the forward and return stroke piston efforts if required.

Types of Actuator

The various linear and torque actuators in common use, together with the various mounting styles, are referred to in the following tables, and are explained in Figs. 7, 8 and 10.

LINEAR ACTUATORS—*Single-acting Cylinders:* These are obtainable either to "push" or to "pull", with or without spring return (see Fig. 8a). Double piston rod models are also available. In the single-acting cylinders, oil under pressure is piped to one side of the piston only, the return stroke being accomplished by diverting the oil back to the oil tank when the return stroke is actuated, either by gravity, internal or external springing, or some other external force mechanism. Spring-return types are limited in bore and stroke, the spring being the controlling factor.

Particular attention must be paid to working conditions when considering the possible use of a single-acting cylinder, as dirt, grit and moisture drawn into the cylinder breather holes are liable to cause rapid wear of cylinder barrel, piston rings and other parts.

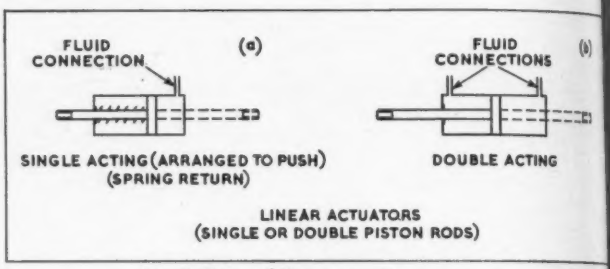


Fig. 8. Types of linear actuator.

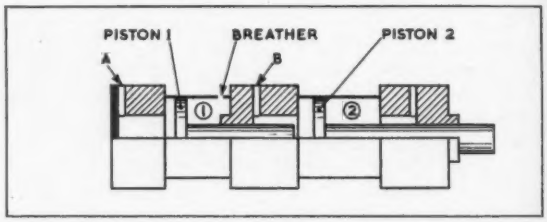


Fig. 9. Section through a three-position actuator.

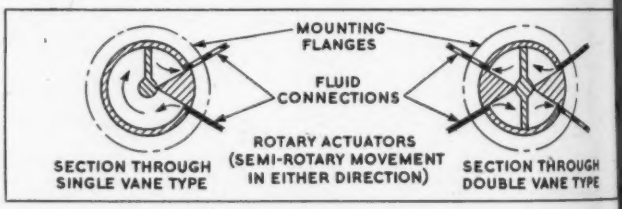

MOUNTING FLANGES
FLUID CONNECTIONS
SECTION THROUGH SINGLE VANE TYPE
ROTARY ACTUATORS (SEMI-ROTARY MOVEMENT IN EITHER DIRECTION)
SECTION THROUGH DOUBLE VANE TYPE

Fig. 10. Rotary actuators.

Double-acting Cylinders: In double-acting cylinders (see Fig. 8b), pressure oil is admitted to one side of the piston, the other side of the piston being piped to return to the tank. The return stroke is effected by reversing the pressure oil supply and return lines (see Figs. 1a and 1b).

These cylinders are used when relatively high forces are required in both directions, or when more positive return characteristics are necessary. Double-ended piston rod models can be utilised so that the piston effort in either direction is the same, or so that equal piston speeds in either direction are available, as mentioned above. Extended piston rods can be used on single- and double-acting cylinders to trip the various valves necessary to operate a circuit sequence.

Telescopic Cylinders: Where long strokes are required at relatively short closed centres, i.e. such as on a commercial vehicle equipped with a tipping arrangement, telescopic cylinders may be used. With these, due attention should be paid to the imposed loads when the cylinders are in the extended position.

Positional Cylinders: These actuators provide a compact and accurate method of obtaining a number of distinct rod positions. A typical application of the three-position cylinder shown in Fig. 9 could be applied in conjunction with a three-speed gearbox. The actuator consists of two separate pistons on their own rods (not connected). When pressure is applied at connection *A*, both piston assemblies advance the end of the stroke of cylinder *1*, thus establishing the mid-position. The complete advance stroke is accomplished by maintaining pressure on cylinder *1* and applying pressure to cylinder *2* via connection *B*, thus pushing piston assembly number 2 forward. The return stroke can be made to mid-position or to end of stroke, according to the valve arrangements.

ROTARY ACTUATORS—Fig. 10 shows sections through typical single and double vane torque actuators, with a rotation of less than 360°. These actuators can be fitted in a hydraulic circuit in the same manner as the linear type actuators, and may be used in many different applications. In certain applications they may replace linear type actuators used with lever mechanisms for torque applications, where space available for installation is limited. With rotary actuators it is advisable to incorporate external stops in the installations, so that the separators within the actuators are not used to limit the rotation of heavy loads.

Other torque actuators of a more complicated nature giving rotation(s) greater than 360° are also available with built-in cushioning and are described in the following tables. These tables also list some of the specialised electro-hydraulic types.

Piston Seals

Where leakage across piston assemblies is not permissible, particular attention must be given to the type of sealing incorporated in the cylinders. Resilient piston cups are usually employed when absolute sealing is required. Where this requirement is not essential, metallic piston rings can be used, these being advantageous in that generally a longer service life can be expected.

The following companies are among those which manufacture actuators to special order only:

Automatic Products Co. Ltd.
Boulton Paul Aircraft Ltd.
British Messier Ltd.
Dunlop Rubber Co. Ltd.
Exactor Ltd.
Fairey Engineering Ltd.
H. M. Hobson Ltd.
The Leeds Engineering & Hydraulic Co. Ltd.
Lockheed Aircraft Hydraulics Division.
Mitchell Hydraulics Ltd.
The Plessey Co. Ltd.
Skyhi Ltd.

PRINCIPAL MANUFACTURERS AND SUPPLIERS OF HYDRAULIC ACTUATORS

LINEAR ACTUATORS

Associated Electrical Industries Ltd.

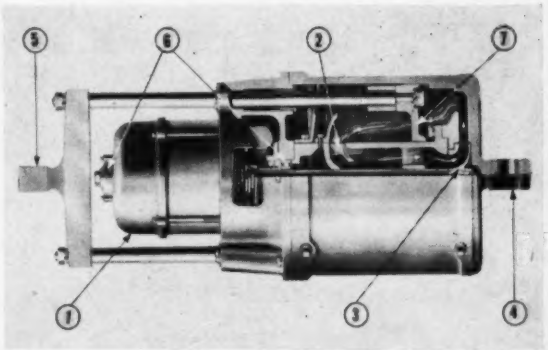
The A.E.I. Electro-hydraulic Thrustor is a self-contained unit, no valves or external piping being required. The only external connection necessary is the electrical wiring. The essential details and principle of operation can be followed from the accompanying illustration.

1. Impeller motor, the shaft of which is extended to carry an impeller (3).
2. One of the four ports in the hollow stem, to provide a path for the oil flow between upper and lower chambers of the oil cylinder, via the impeller.
3. Centrifugal impeller which pumps the oil from the upper into the lower chamber, thus forcing up the piston. When the motor stops, the oil flows back through the stationary impeller, thus allowing piston to return quickly.
4. Bottom lug for mounting the thrustor.
5. Top lug, which is forced up by movement of the piston.
6. Ball-bearings carrying the motor shaft. The top bearing is grease packed, and the bottom bearing splash lubricated.
7. Piston directly coupled to upper clevis by two rods passing through bushed glands.

Except for the 40-lb.-thrust model (listed above), which is manufactured as an "industrial" type only, all models are available in "industrial" or "flameproof" form. A time-lag device on power or return stroke, or both, can be fitted to all types. These time-lag devices consist of internal oil-flow controls which are adjustable externally, thus allowing gradual application and/or release of the pressure.

Standard Thrustors

Input Watts	Thrust (lb.)	Stroke (in.)
90	40	2
150	75	2
180	100	2
170	150	3
200	250	3
420	500	5
580	650	5
700	800	8
700	800	12



A.E.I. Thrustor, type TK 1503.

Baldwin Industrial Controls

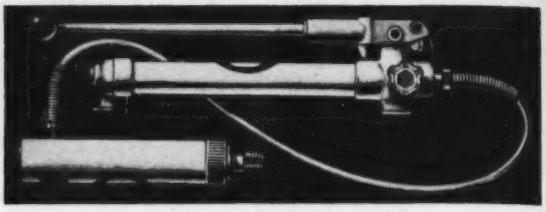
All sizes are obtainable with single and double piston rods, cushioned at front and/or rear end, or non-cushioned. Maximum operating pressure is 250 p.s.i. These units may also be used as pneumatic actuators at a maximum pressure of 150 p.s.i. They are suitable for temperatures up to 70 deg. C., with strokes to order.

Bore (in.)	Standard port size (B.S.P.)	Piston rod end (B.S.F.)	Standard mountings
1½	¼	⅜	C, D, E, F, G, J; M
2⅜	¼	⅝	
3	⅜	¾	
4½	½	1	
6	¾	1½	
8	1	1½	

Blackhawk Ltd.

All cylinders except those marked otherwise are arranged to push. The hollow ram cylinders are for pushing and pulling.

A comprehensive range of end fittings, tubes, pullers for sprocket removal, clamps, pumps, etc., is available for use with all cylinders and various kit forms are also available.



Blackhawk Porto-Power unit.

Porto-Power single-acting cylinders

Cylinder dia. (in.)	Standard stroke (in.)	Piston rod dia. (in.)	Piston rod external end thread N.P.T. (dia. × t.p.i.)	Self-retracting	Standard mounting—tapped holes at rear end of cylinder N.P.T. (dia. × t.p.i.)	Capacity (tons)
1¼*	5	¾	¾ in. × 14	Yes	¾ in. × 14	2
	3	1·0	None	No	None	4
1⅝	5	1·0	¾ in. × 14	Yes	¾ in. × 14	4
	⅜	1·0	None	No	None	4
2¼	2½	1⅜	None‡	No	None	7
	6	1½	1¼ in. × 11½	Yes	1¼ in. × 11½	10
	10	1½	1¼ in. × 11½		1¼ in. × 11½	10
3⅜	13½	2¼	2 in. × 11½		2 in. × 11½	20
3⅜	5	2¼	2 in. × 11½		2 in. × 11½	20
5	6	3½	None		None	50
		Int. (N-2B)				
3⅞†	2	2	1 9/16 in. × 16	Yes	⅜ in. × 16 (two holes)	20
4½†	2½	2½	1 13/16 in. × 16	Yes	⅜ in. × 16 (two holes)	30
6¼†	3	3⅜	2⅞ in. × 12	Yes	¼ in. × 13 (two holes)	60

* *Arranged to pull.* † *Hollow ram cylinder.* ‡ *Indicates units supplied with special mule adaptor for ram plunger 1¼ in. × 11½ t.p.i.*

Bosch Ltd.

In addition to the cylinders listed below, other cylinders are available with piston strokes from 1·97 in. to 15·75 in. (It should be noted that this company's equipment is manufactured to metric dimensions, and that the figures given in these tables are approximate equivalents.)

Typical Bosch hydraulic cylinder.

Single- and double-acting cylinders (with sealed pistons for pressure up to 2,100 p.s.i.)

Bore (in.)	Standard stroke (in.)	Closed length (in.)	Piston rod dia. (in.)	Standard mounting
1·57	2·36	12·2	0·787	G
	6·3	16·1		
	7·9	17·7		
1·97	6·3	16·1	0·985	
	7·9	17·7		
	12·6	22·45		
2·56	5·5	17·9	1·18	
	7·9	20·3		
	10·0	22·2		
	12·6	25·0		
3·15	3·9	15·0	1·38	
	5·5	17·9		
	7·9	20·3		
	15·75	28·1		

Single-acting cylinders with plunger pistons (displacement type)

Bore (in.)	Standard stroke (in.)	Closed length (in.)	Standard mounting
0·985	5·5	10·25	G
	7·1	15·0	
	7·9	12·6	
	7·9	17·7	
1·38	5·5	10·25	
	7·9	12·6	
	13·8	23·6	
1·57	5·5	11·4	
	7·9	13·8	
	15·0	26·6	
	16·35	23·6	

H. S. Cattermole & Co. (Hydraulics) Ltd.

1. Adjustable hydraulic cushioning can be fitted at one or both ends of stroke.

2. Strokes to order. (Maximum permissible stroke is approximately fifteen times the bore.)

3. Cylinders are designed for working pressure of 1 t.s.i. with oil as the operating medium, but may be modified for water operation if specially requested.

4. Cylinders are available with two types of piston assembly: those fitted with piston rings, where a sustained load is not required, and only movement under load is required; and those fitted with synthetic rubber packings where a sustained load is required.

5. Radial position of ports and bleed points is available as required.

6. Special mountings, including trunnion with universal bush, can be supplied.

7. Other cylinders available include cylinders with centre trunnion mountings, and telescopic cylinders for heavy earth-moving equipment, etc.

General-purpose double-acting cylinders				*Standard machine tool cylinders, double-acting*		
Bore (in.)	Standard port (B.S.P.)	Piston rod end plain dia. (in.)	Standard mounting	Standard port (B.S.P.)	Piston rod end (B.S.F. ext.)	Standard mounting
1½	¾	1	C, D, G, J	¾	¾	C, D, G, J
2	⅞	1¼		⅞	1	
2½	1	1½		1	1¼	
3	1	1¾		1	1¼	
3½	1	2		1	1¼	
4	1¼	2½		1¼	1½	
4½	1¼	2½		1¼	1¾	
5	—	—		1¼	2¼	
5½	—	—		1¼	2½	
6	—	—		1¼	2¾	
Single-acting cylinders can be supplied						

Electro Hydraulics Ltd.

Telescopic cylinders (two expansions)

Bore (in.)	1st stroke (in.)	2nd stroke (in.)	Closed length (in.)
3·5 and 6·0	36·0	72·0	96·375
	26·5	57·0	69·375
	31·0	66·0	78·375
*	41·5	83·0	99·375
	23·5	47·0	66·375
*	26·0	52·0	76·375
	27·0	54·0	78·375
	26·5	57·0	69·375
*	32·0	64·0	88·375
*	35·0	74·0	86·375
*	41·5	83·5	99·375

** These items have been produced to customers' special requirements, and are not standard equipment.*

Single-acting cylinders

Bore (in.)	Standard stroke (in.)	Standard port (B.S.P.)	Piston rod dia. (in.)
3	36	½	1·98
3	54	½	1·98
3	72	½	1·98
3*	84	½	1·98
3*	99	½	1·98
3*	108	½	1·98

Double-acting cylinders

Bore (in.)	Standard stroke (in.)	Standard port (B.S.P.)	Piston rod dia (in.)	Standard mounting
3·50	5·0	¼	1·312	G
4·0	4·125 and 5·625	¼	1·312	G

Epco Ltd.

A comprehensive range of end fittings, extension tubes, frame clamps, portable and bench press frames, bearing extractors, pumps, etc., is available for use with the cylinders.

Various kit forms are available, e.g. pipe bending outfits, puller outfits, maintenance outfits, etc.

(a) Cylinder arranged to push.

(b) Cylinder arranged to pull.

(c) Hollow ram cylinders (for pushing and pulling).

(d) By adaptor.

Single-acting cylinders

Cylinder outside dia. (in.)	Standard stroke (in.)	Piston rod dia. (in.)	Piston rod male end thread ‡	Self-retracting	Standard mounting ‡ (at rear end of cylinder) M—male thread F—female thread	Capacity (tons)
(a) 1½	5	1	¾ in. B.S.P.	Yes	¾ in. B.S.P. (F)	3½
(a) 1⅞	¾	1	None	No	None	3½
(b) 2½	6	1 3/16	1¼ in. B.S.P.	Yes	1¼ in. B.S.P. (F)	3½
(a) 2½	2½	1⅜	(d) 1¼ in. B.S.P.	No	None	6
(a) 2½*	6	1½	1¼ in. B.S.P.	Yes	1¼ in. B.S.P. (F)	8
(c) 3	6	1¾	None	Yes	2¼ in. × 12 t.p.i. Whit. (M)	10
(a) 3⅜*	5	2⅜	2 in. B.S.P.	Yes	2 in. B.S.P. (F)	20
(a) 4½	5	2½	None	Yes	None†	30
(a) 5½	6	3½	None	Yes	None†	50
(c) 5½	5	3½	None	Yes	None†	30
(a) 7¾	6	5¼	None	No	None†	100

** These cylinders are available with strokes up to 12 in. maximum.* *† These cylinders can be anchored by holes drilled and tapped in base (in fixed locations).* *‡ B.S.P. threads are taper.*

Gullick Ltd.

This company manufactures hydraulic self-advancing roof supports, rams, pumps, etc., designed for applications in the mining industry. The hydraulic fluid used is a soluble-oil/water mixture (predominantly water) which is 100 per cent non-inflammable.

Hydraulics & Pneumatics Ltd.

The actuators manufactured by this company are of the "valve in piston" type, the valve mechanism incorporated in them having been subjected to exhaustive tests during the development of aircraft flying controls, including tests in the range −60 to +70 deg. C. Tests have proved that the valves used will operate without failure under adverse conditions. The non-leak valves function also to lock the actuator, which is suitable for operation by pre-charged hydraulic accumulator for long periods.

Two basic designs are available, the control being mechanical or electrical. The mechanical control model may be used as a conventional cylinder and valve or as an accurate servo-control cylinder. Shown at (a) is a section through this design with servo-control. The electrically controlled model features a solenoid-operated selector valve which maintains a constant speed in either direction when energised, as shown at (b).

Referring to (a), pressure *P1* from an accumulator or pump continually pressurises volume *V1* and acts on the piston area *S1*. The annular area *S1* is arranged to be approximately half that of area *S2*, and when the oil is trapped in volume *V2* the pressure *P2* is equal to half *P1* for no external actuator load.

Valve *B1* connects *V1* and *V2*, while valve *B2* connects volume *V2* to the exhaust. When the control rod is static these two valves are closed and there is no flow.

If the control rod is moved in an outward direction, valve *B1* opens and allows pressure *P2* to rise to a value which will balance the external load. The piston moves in the same direction as that of the control rod, and comes to rest when the control rod is stationary and valve *B1* is again closed.

When the control rod is moved inwards, valve *B2* opens, allowing pressure *P2* to fall to a value which differentially balances the external load. The follow-up movement of the piston is as before, with the valve *B2* eventually closing when stationary.

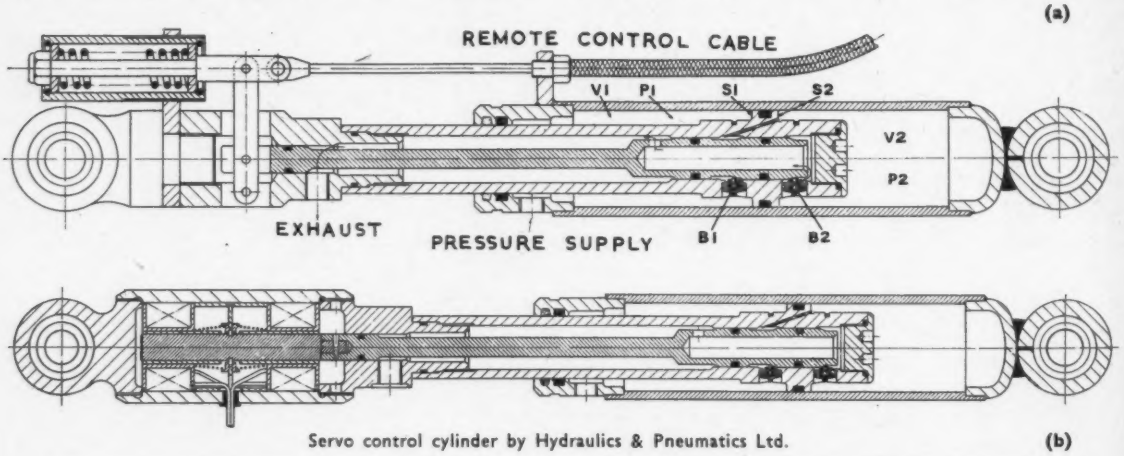
Details of models available

Bore (in.)	Stroke (in.)	Effective ram area (sq. in.)	Max. working pressure (p.s.i.)
2	6 and 12	1·57	2,500
3	6 and 12	3·6	2,500
6	12	14·2	2,000

Double-acting cylinders (air or hydraulic to 200 p.s.i.)
Modernair range of cylinders

Bore (in.)	Stroke (in.)	Standard port B.S.P. taper thread	Piston rod dia. (in.)	Standard mounting
Stud Mounted				
1·125	24 in. max.	$\frac{1}{8}$	0·3125	A
Economair				
1·125	To order	$\frac{1}{4}$	0·375	A, B, C, D, G, H, J, K, M, O
2·0	To order	$\frac{1}{4}$	0·625	
3·0	To order	$\frac{3}{8}$	0·750	
4·0	To order	$\frac{1}{2}$	1·0	
Provenair				
6·0	To order	$\frac{3}{4}$	1·25	C, D, G, J, M

In the Economair and Provenair series, there are double-end rod and single-acting spring-return cylinders available. Tandem in-line cylinders are available in the 1·125, 2·0 and 3·0-in. bore cylinders.



Servo control cylinder by Hydraulics & Pneumatics Ltd.

Keelavite Hydraulics Ltd.

All cylinders are available in strokes to order. Adjustable cushioning may be provided at either or both ends of the cylinder. Maximum working pressure is 2,000 p.s.i. (1,500 p.s.i. in certain cases).

Double-acting cylinders

Bore (in.)	Piston rod dia. (in.)	Standard mounting
1	$\frac{5}{8}$	C, D and G. C and D combined, and J.
$1\frac{1}{2}$	$1\frac{1}{16}$	
2	1 and $1\frac{3}{8}$	
$2\frac{1}{2}$	$1\frac{3}{8}$ and $1\frac{13}{16}$	
4	2 and $2\frac{7}{8}$	
5	$2\frac{1}{2}$	
6	$3\frac{1}{4}$	
$7\frac{1}{2}$	4	

Lockheed Precision Products Ltd.

These cylinders are for use with a working pressure of up to 1,000 p.s.i. A rubber gaiter for piston rod protection is supplied as standard. A fork end for the piston rod, with a locking nut for adjustment, is normally supplied.

In the table, non-locking cylinders (NL) are recommended for use with Hydroloc valves where excessive vibration of the mechanism operated, or reaction in loading conditions, render the Autoloc mechanism unsuitable.

Auto indicates Autoloc cylinders. These cylinders are of the same dimensions as the non-locking types, but incorporate an internal mechanical locking device arranged so that when the piston has been moved to any desired point in the stroke range by hydraulic pressure, the piston automatically locks in that position as soon as the fluid pressure ceases. When it is desired to move the piston, the fluid pressure applied to the appropriate end of the cylinder automatically frees the locking device, thus affording freedom of movement. The piston cannot be moved by external forces.

Other cylinders available include:

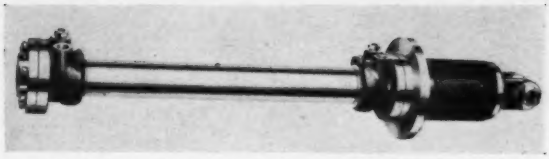
Single-acting types

1. 4½-in.-dia. piston displacement type "lift" cylinder, with a flat base for mounting. Strokes up to 8 ft. Working pressures up to 2,000 p.s.i.

2. 3⅛-in.-dia. ram displacement "lift" cylinder with a round base (lugs for location only). Strokes up to 8 ft. Working pressures up to 2,500 p.s.i.

3. 3-in.-dia. ram displacement type "lift" cylinder with a round base (lugs for location only). Strokes up to 7 ft. Working pressures up to 2,500 p.s.i.

4. 3-in.-dia. ram displacement type with eye ends (for pin mounting and for ram end). Pressure connection is via the eye end of the ram. Strokes (normal) up to 2 ft. Working pressures up to 2,500 p.s.i.



Lockheed 2½-in. high-duty cylinder with flange mounting.

Double-acting types

1. 2½ dia. × 1¾ (rod dia.) × 22·0 in. stroke, with eye ends (for cylinder end and for piston rod). Other strokes are possible. Working pressures up to 2,500 p.s.i.

2. 2½ dia. × 1 (rod dia.) × 4½ in. stroke; cylinder of through bolt construction with self-aligning mountings (eye ends). Other (short) strokes are possible. Working pressures up to 2,500 p.s.i.

3. 3 dia. × 1⅜ (rod dia.) × 4½ in. stroke; cylinder of through bolt construction; self-aligning mountings (eye ends). Other (short) strokes are possible. Working pressures up to 2,500 p.s.i.

4. 5¼ dia. × 2½ (rod dia.) × 20·0 in. stroke; cylinder of through bolt construction; eye ends (for cylinder end and for piston rod). Other strokes are possible. Working pressures up to 2,000 p.s.i.

5. 3 × 1¾ (rod dia.) × 9 in. or 12 in. stroke; cylinder of welded construction with screwed-on lower head. Pin mounting or with flanged lower head. Suitable for high temperatures. Can be made in other sizes, viz.: 5¼ × 2½; 6 × 2½; 6 × 3; and 7 in. × 3 in. (all with various strokes).

Double-acting cylinders—non-cushioned

Bore (in.)	Standard stroke available (in.)	Standard port (B.S.P.)	Piston rod dia. (in.)	Piston rod end (B.S.F. external)	Fork end pin dia. (in.)	Standard mounting
⅞	2 and 6	¼	⅝	½	0·5 NL only	C, D and G.
1½	6 and 10*	¼	1⅛	⅝	¾ NL and Auto	
1¼	6 and 10*	¼	1	⅝ (B.S.P. external)	¾ NL	
1¾	10 and 14*	⅜	1	½	1·0 NL and Auto	
1¾	10 and 14*	⅜	1⅜	½	1·0 NL only	
2½	Up to 60·0 (a)	½	1⅜	1·0	1⅛ NL only	
2½	Up to 60·0 (a)	½	1⅝	1·0	1⅜ NL only	
3	Up to 60·0 (b)	½	1⅝	1¼	1⅜ NL only	
3	Up to 60·0 (b)	½	2⅛	1¼	1⅜ NL only	
4	Up to 60·0 (b)	1	2⅛	1½	1⅝ NL only	
4	Up to 60·0 (b)	1	3	1½	1⅝ NL only	

*(a) or 80 in. without boot. (b) or 100 in. without boot. * Non-locking types up to 32-in. stroke are available.*

(To be concluded next month.)

PYROFERAL HEAT-RESISTING ALLOY

It has been claimed that a heat-resisting alloy (Pyroferal) developed at Statni Vyzkumny Ustav Materialu A Technologie, Prague, containing no alloying additions other than aluminium, is less costly than nickel-chromium alloy heat-resisting steels, and is equal to them in many physical respects. The chemical composition of Pyroferal is: C, 1-1·2; Al, 29-31; Mn, 0·7 max.; Si, 0·5; P, 0·4; S, 0·1 per cent. Due to the high aluminium content, its specific gravity is about one-third lower than other heat-resistant steels and irons.

The matrix of Pyroferal is a eutectic of aluminium-iron solid solution and aluminium carbide with small amounts of primarily precipitated carbides. Up to its melting point at 1,235 deg. C., the alloy does not undergo any structural changes, and its heat resistance is maintained even close to this temperature by the formation of a protective layer of aluminium oxide.

Pyroferal is a casting alloy; its main features are the smooth, clean surfaces which can be obtained, and the ease with which the castings can be fettled. A tensile strength of about 50,000 p.s.i. can be obtained, Young's modulus being approximately 21 × 10^6 p.s.i. Comparative creep tests under bending stresses have shown that Pyroferal is comparable to an austenitic Cr-Ni steel of the 24/20 type up to temperatures of 1,000 deg. C. Under long-service high-temperature conditions no embrittlement takes place—rather there is a slight increase in ductility.

General view of the British Standards Institution's testing centre at Hemel Hempstead.

STANDARDS AND STANDARDISATION IN THE NATIONAL ECONOMY

This article consists of extracts from a paper given by the author at a course on Standardisation in Engineering, organised by the Huddersfield College of Technology, in October 1959

by H. M. GLASS, M.Sc., Ph.D., F.R.I.C. *

AT this point of time, no justification of standardisation activity in industrial countries is necessary. The pattern of industrial development up to the stage of highly organised national production has been followed by all great industrial countries in the past, and the same pattern is to be observed now in developing countries—for example, those of the Middle East and Asia. Somewhere along this route there is the emergence of the idea that an important factor contributing to further industrial growth will be co-ordinated effort in standardisation. In the United Kingdom the idea came to life at the very end of the nineteenth century: the time was just right for this country. In other countries co-ordinated standardisation has come into being sometimes early, as in India or the Lebanon, and sometimes comparatively late, as in U.S.A.

The Lemon Committee

In 1948, the Ministry of Supply set up a special committee under the chairmanship of Sir Ernest Lemon to report on the standardisation of engineering products. The terms of reference assigned to the committee were "to investigate . . . the methods by which manufacturers and users of engineering products determine whether any reduction in the variety of products manufactured is desirable . . . ; to report whether these methods are adequate . . .".

The Lemon Committee went to some pains to define three very important terms:

1. *Specialisation:* defined as the process whereby particular firms concentrate on the manufacture of a limited number of products or types of products.
2. *Simplification:* defined as the process of reducing the number of types of products made (or called for) within a definite range.
3. *Standardisation:* defined as the process of applying the "conditions" necessary to ensure that a given range of requirements can normally be met, with a minimum of variety, in a reproducible and economic manner on the basis of the best current technique.

The Committee made a number of important recommendations which in the course of the past ten years have been implemented on an ever-growing scale†

The terms defined by the Lemon Committee lend themselves to application not only in individual films but in much wider communities as well. Specialisation is obviously something which a single firm will wish to apply if it aims at maximum productivity. But it is also likely that a number of firms, particularly those forming a commercial group, will each agree to specialise in certain products not made by other members of the group so that, while each factory achieves maximum productivity, a combined sales organisation can ensure that the potential customer is made aware of the whole range of products made by the group. This system has been applied on a very large scale in the U.S.A., with obvious benefits.

The process of simplification can also be applied by

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† *The report of the Committee is published by H.M. Stationery Office, S.O. Code No. 70-611.*

the single firm, but will be of greatest benefit to the national economy if applied throughout whole sections of industry. The maximum benefit will be derived when major industries combine to ensure that their separate requirements involving simplification are translated into a nation-wide activity. This leads immediately to the development of national standards which incorporate agreed views on simplification, and on criteria for assessing the qualities of the nation's products.

Growth of the B.S.I.

The British Standards Institution was founded in 1901, when it was known as the Engineering Standards Committee. It started with a marked engineering bias and even today, when its work has extended into many fields other than engineering, as a rough guide it would be right to say that about 60 per cent of its activities are directed to the engineering and metals trades. Of the rest of its work, about 30 per cent goes to chemcials and building together, and the remaining 10 per cent to textile and other industries.

In 1918 the organisation was reconstituted as the British Engineering Standards Association. By 1931 so many other industries were seeing the need for standardisation at the national level that the British Standards Institution was created. At the present time the B.S.I. has published 3,200 national standards, and about 300 new and revised standards are published each year. More than 1,200 standardisation projects are currently being developed.

How a National Standard is Prepared

Proposals for the preparation of standards may come from any quarter—from the manufacturers of a product, or its users; from Government departments (whether as users or as concerned with regulations which may specify the use of British Standards); or from B.S.I. committees already working on standards. Before work is started on any proposal it must be clear that there is support for it from responsible bodies. The Technical Committee itself is formed of representatives of organisations directly concerned with the project under consideration.

When the initial drafting of a standard has been completed, it is circulated as a "draft for comment" to all appropriate interests (including the standards bodies in other parts of the world, under agreed arrangements). When comments are received they are considered by the responsible Committee, and adopted, modified or rejected according to the consensus of informed Committee opinion. A draft, as finally agreed by the Technical Committee, is then submitted to the relevant Industry Standards Committee for approval. British Standards are published only if they have the substantial support of manufacturers and users, and the procedures described are aimed at securing the general consent of those concerned with any standard.

Differences of view on the substance of a standard which arise in the course of any Technical Committee's work are not resolved by resort to a vote. For this reason, though a fair balance of interests is accepted as desirable, it is not necessary that there should be a numerically equal representation of different interests, which are in any case likely to be of varying importance. If a difference of view cannot be overcome at the technical level, the problem is referred to the Executive Committee of the B.S.I. General Council for settlement. This procedure was approved by the Cunliffe Committee which reviewed the organisation and constitution of B.S.I. in 1950,* and whose conclusions were endorsed by industry and the Government.

B.S.I. committees do not relinquish their interest in a British Standard as soon as it is published, but continue to review it in the light of subsequent trade and user experience and of new technological developments, so that amendments or revisions can be introduced when needed. Every British Standard lists the trade, professional and other interests which have taken part in its preparation.

Types of British Standard

There are certain well-defined categories of British Standard. These are:

GLOSSARIES OF TERMS—These set out terms and definitions appropriate to different sections of industry, thus providing a common, easily-understood, technical language for industry.

STANDARD METHODS OF TEST—Another class of standard covers methods of testing and measurement, which are of fundamental importance in trade.

SPECIFICATIONS—Methods of test have a most important application in industry in the assessment of the quality of products. The B.S.I. issues specifications covering quality or performance for a wide variety of goods, the purpose being to ensure that the product will be fit for the job it is designed to do. Such standard specifications may cover both dimensional and property characteristics.

In regard to properties, whether physical of chemical, the traditional method is to state a limiting value for one or more properties, and these must be attained before the product can be said to comply with the standard. A move has started, however, to introduce property values based on a statistical approach, so that the limiting value of the property to be expected is related to the size of the sample and the frequency of sampling. Specifications of this type lend themselves excellently to statistical quality control at the maker's works.

Some standards concentrate on dimensions alone. These are very important in engineering, because, as a rule, tolerances are laid down. BS 21 on pipe threads can be taken as an example, although thread forms are also specified.

CODES OF PRACTICE—Another sort of British Standard publication sets out the best methods of installation, use and maintenance of equipment. These are referred to as Codes of Practice. They cover the building, electrical, civil and mechanical engineering industries. Many other standards, although not called Codes of Practice, offer guidance on good practice.

The Force of British Standards

With one or two exceptions, a British Standard is an instrument drawn up by voluntary agreement and brought into use by voluntary application. There is no compulsion on the community to adopt British Standards, whereas in some countries, national standards have the power of law.

The B.S.I. has adopted a recommendation made by the Cunliffe Committee that standards should be reviewed at intervals of not more than five years. That is why an increasing number of British Standards have been revised, or, if revision has proved unnecessary, have been confirmed as satisfying up-to-date practice in industry.

The B.S.I. Certification Mark

As part of the voluntary system operated by the B.S.I., it is open to any manufacturer to ask for the right to use the B.S.I.'s certification mark (the "Kite" mark) as an indication that his product complies with a British Standard, and is backed by the assurance of the Institution. Before this right is granted, the B.S.I. must satisfy itself, by independent testing, that the product fulfils the requirements of the standard, and that the maker's factory will continue to produce satisfactory articles.

The essential virtue of the certification mark system to the user is that he is relieved of the necessity of undertaking tests to make sure that the product complies with the standard.

** The report of the Committee is published by H.M. Stationery Office, S.O. Code No. 51-309.*

NEW IDEAS IN DESIGN

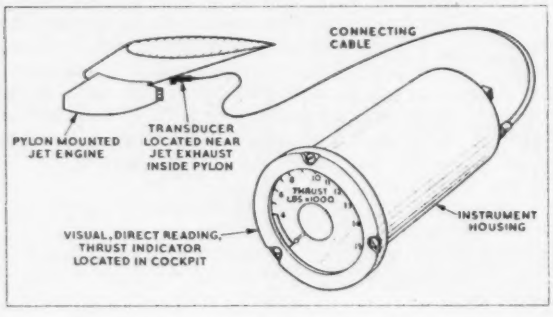
Outstanding products in current manufacture

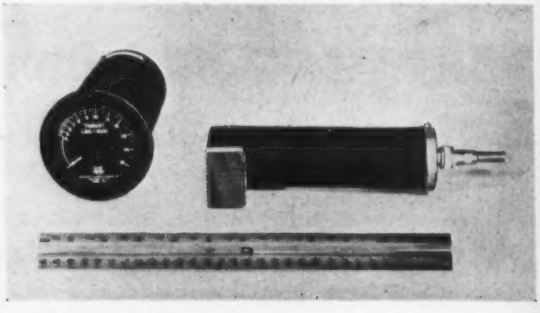
New Device Measures Jet Thrust by Jet Noise

A NEW sonic device called a jet thrust indicator, recently developed by The Industrial Acoustics Co. Inc., of New York City, is claimed to enable the thrust of a jet engine to be measured instantaneously. The instrument was developed to provide added safety as a take-off monitor, as well as an in-flight fuel economiser. It consists of two parts: a transducer which is located near the jet exhaust, and a visual direct-reading thrust indicator located in the cockpit; this instrument measures directly in lb.

The model T1-1 accepts one input from its matched transducer, which is located in close proximity to the jet exhaust. This transducer is housed in an aluminium shell, and is thus isolated from shock and vibration. Tuning and directional characteristics permit operation in multi-engined aircraft without engine-to-engine interference.

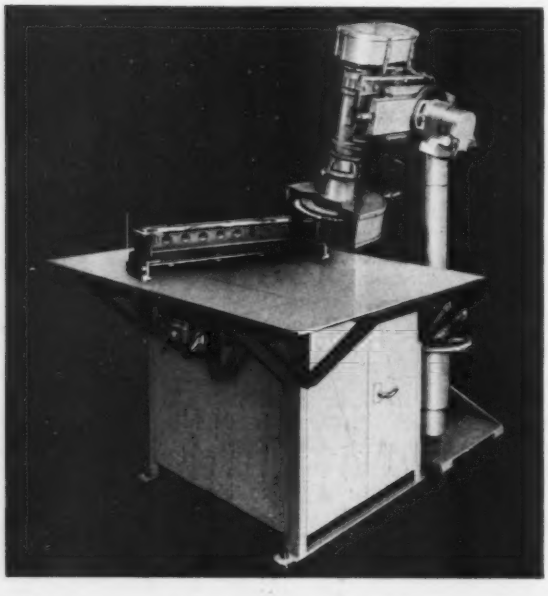
Rapid field calibrations and checks are simply performed by operating the engine at a known thrust setting in the upper half range. The meter is then adjusted to the correct scale reading with a screw-type calibrator at the rear of the instrument housing. Model T1-1 is designed for use with engines from 4,000 to 15,000 lb. thrust. Other models are available for higher thrust engines.


CONNECTING CABLE
PYLON MOUNTED JET ENGINE
TRANSDUCER LOCATED NEAR JET EXHAUST INSIDE PYLON
INSTRUMENT HOUSING
VISUAL, DIRECT READING, THRUST INDICATOR LOCATED IN COCKPIT



Chain-driven Jigs in Profile Polishing Machine

METAL polishing can be a very expensive operation. Although it is sometimes possible, when very large numbers of components are involved, to devise a machine having a number of polishing heads, such machines are clearly out of the question when smaller quantities are involved, and where there is a constant switching from one type of component to another.

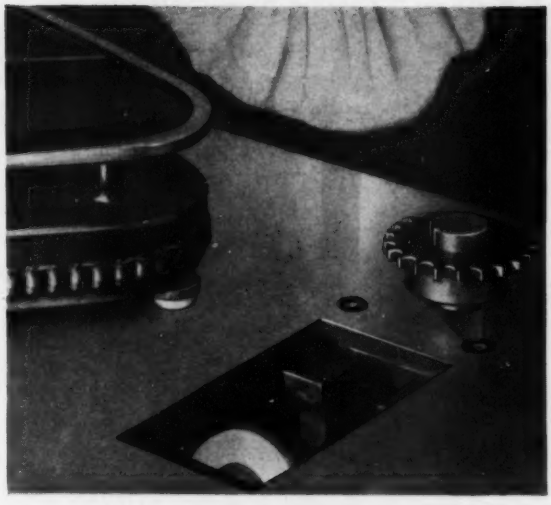


To meet the need for a machine that will deal with the polishing in batches of such profiled components as car window vent frames, clock bezels, profiled metal beadings, shaped strip surrounds and similar components, B.O. Morris Ltd. have recently introduced a unit that makes use of an interesting jigging system. Known as the CFT.40, this machine consists of a worktable and a polishing head which can be raised, lowered and inclined at any angle. Immediately under the polishing head is a chain sprocket, driven by an electric motor via a variable speed drive unit in the pedestal, and a retractable friction-drive wheel which maintains the chain in engagement with the sprocket. The pressure roll is pneumatically controlled and can be retracted fully below the face of the table. An air system for controlling the liquid compo feed on to the mop is built in,

and cams are provided for adjusting the spray feed timing. An air service unit, together with reducer valves and pressure gauges, is built in to the pedestal, and a foot control valve for the liquid compo spray can be supplied instead of the automatic timing arrangement.

A typical jig is illustrated. Such jigs are tailored to suit the component, and usually consist of a base shaped to the required profile, with a roller chain to follow both concave and convex edges. The base is fitted with low friction foot pads, and on the top are quick-action clamps for rapid loading and unloading of components. Edge grinding can be carried out using a band attachment on the polishing head, instead of a mop.

The standard table on Model CFT.40 is 40 × 30 in., but a special large table (60 × 40 in.) can be supplied. With the heavy polishing head (5, 7½ or 10 h.p.) the maximum mop size is 16 in. dia. × 5 in. wide; the light polishing head (3 or 5 h.p.) has a maximum mop size of 12 in. dia. × 3½ in. wide. An external compressed air supply of 15 c.f.m. at 60 p.s.i. is required.

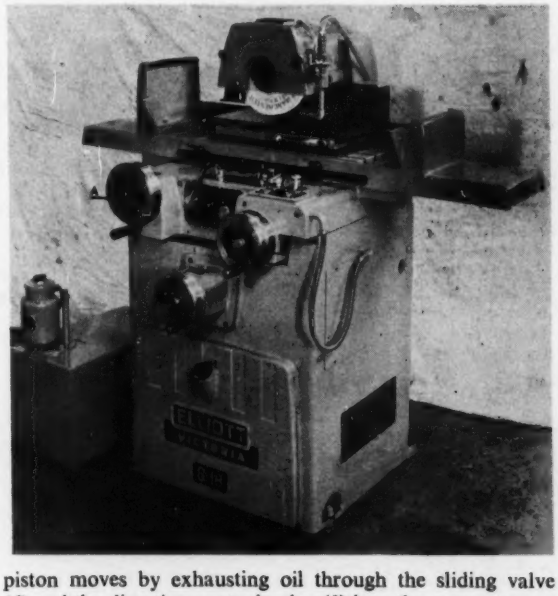


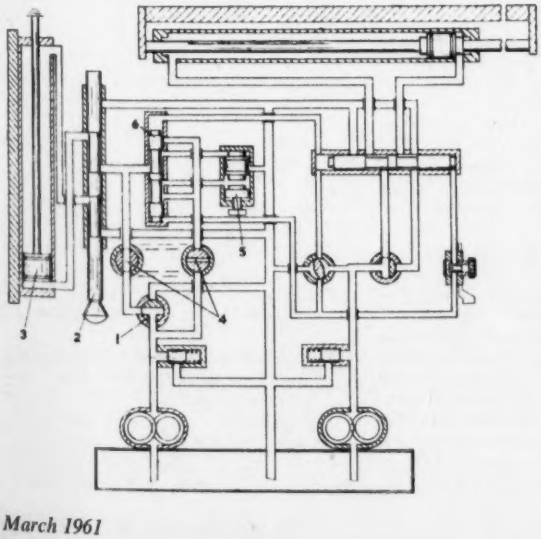
Surface Grinder with "Criss-cross" Grinding Feature

AMONG the features of a new surface grinder (the Accuramatic 18/18) made by B. Elliott (Machinery) Ltd. is a direct-acting hydraulic cross-traverse motion to provide "criss-cross" grinding as well as grinding by step traversing. The advantage of this new grinding technique is that it permits surfaces to be ground with perfect overall flatness, while very minute and regular undulations allow the surface to retain an oil film. An additional advantage is that it enables surface grinding to be carried out on very thin material without burning and discoloration.

The speed of the criss-cross grinding movement is controlled by the rotary throttle valve (*1*). Fluid passes from this valve through the upper part of the rotary selector valve (*4*), through a slide valve (*2*), controlling the direction of cross-traverse, and into the cross-traverse cylinder (*3*). The direction control valve (*2*) is operated by hand or mechanically by the trip dogs.

To obtain stepped feed at table reversal, the rotary selector valve (*4*) is turned to cut out the supply for the above movement and substitute a choked supply through the lower portion of the valve. This supply is independent of the throttle valve (*1*) and passes through an auxiliary slide valve (*6*) into the metering valve (*5*). The metering





piston moves by exhausting oil through the sliding valve (*6*) and the direction control valve (*2*) into the cross-traverse cylinder (*3*). The volume of this metered charge is controlled by screwing in the knob (*5*) on the front of the saddle, thereby reducing the movement of the metering pistons.

The position of the sliding valve (*6*) is determined by the direction of pressure in the table circuit. Therefore, at each reversal of the table the slide valve will move and admit oil to alternate sides of the metering piston. The previously metered charge will then be discharged as described above into the cross-traverse cylinder.

Handwheel *A* enables the table to be traversed longitudinally, and handwheel *B*, graduated in increments of 0·0004 in., is for cross-traversing. Provision is made for "through the wheel" cooling and dust extraction. The pump is driven by a 1-h.p. motor, and has two compartments giving independent sources of pressure fluid for the longitudinal table traverse and the cross-traverse. Thus the operation of the table is not affected by throttling down the cross-traverse movement, or vice versa.

New Books

A Manual of Engineering Drawing for Students and Draftsmen. *By Thomas E. French and Charles J. Vierck.* (*McGraw-Hill—66s.*)

This prodigious work (730 pages), now in its fiftieth year and ninth edition, leaves little unsaid about the craft of draughtsmanship in all its many varied fields. For this new edition the bulk of the text has been revised to accord with the latest practice. The method of presentation has been completely restyled, and is æsthetically pleasing and at the same time very easy to read. All chapters are copiously illustrated with line diagrams and, where necessary, photographs give point to the practical examples discussed in the text.

The early chapters are devoted to fundamentals, such as the selection of instruments and their use, applied geometry, lettering, projection and the use of sections. An excellent chapter covers the approach to auxiliary views, suggesting those which will give a full appreciation of the detail being presented. The more common machine parts are treated with the thoroughness which they deserve. The sections mentioned conclude with the presentation of the General Arrangement and the preparation of schedules.

From this point onward the text becomes a series of more specialised articles covering a broad front. Perhaps the most interesting of these is that which gives an insight into structural and architectural drawing practice. Following this, a survey of cartographical work completes that part of the book, which to the mechanical engineer becomes full of interest when he realises how wide is the scope of "precise drawing".

Further chapters not usually found in a work of this nature deal most efficiently with, among other things, electrical draughting (including the latest printed-circuit techniques), pipework, preparation of graphs and charts, welded items, and jigs and fixtures. The final discussion is of commercial practice and economics, showing: the use of models, especially in the design of chemical plant and associated pipework; symbols which reduce drawing time; and the Photographic General Arrangement, which is steadily gaining favour in the U.K.

From the mass of information presented it is difficult to select any one portion for special mention. However, as a lesson in concise, graphical explanation, the description of intersections and developments is admirable.

The final appendices include mathematical tables, standard parts lists, symbols and abbreviations. Since all of these except the first relate to American standards, they are of little value to the British reader. A comprehensive bibliography concludes this unique work.

To improve the usefulness of the volume as a college text, problems for the student are set at the end of each individual chapter. In addition, further information is available to members of the teaching profession who wish to base a course of instruction on the manual. A series of ten 16-mm. sound films, which serve to add interest to the course work, may be purchased from the publishers.

Though not a volume likely to find its way on to the shelves of many individuals, this book is certainly a worthy addition to any technical library, and a sound basis for an advanced course in engineering drawing.

R. B. Selwyn

Synthetic Rubber Technology: Vol. 1. *By W. S. Penn.* (*Maclaren & Sons Ltd.—50s.*)

Mr. Penn, in the 300-odd pages of this volume, deals with the technology of seven of the more widely used synthetic rubbers. In a companion volume, now in course of preparation, he intends to cover developments in the newer and more specialised polymers.

The polymers considered here are SBR, high styrene resins, butyl, neoprene, nitrile, silicone and polysulphide rubbers. In each case these are discussed under the headings of "Available Grades", "Compounding", "Processing", and in some instances "Applications", all of which are dealt with in a comprehensive and authoritative manner. The introductory chapter covering the selection of polymer type, normally an important consideration for the technologist, is dealt with somewhat less adequately, however, and occupies no more than seven pages of the book.

The author has made extensive use, as he has acknowledged, of manufacturers' literature and published technical data, but this, when blended with his own practical knowledge and experience, has enhanced the usefulness of the book as a source of reference, and at 50s. it must be considered very good value.

Data is presented in tabular form throughout, with the exception of three graphs, and it is somewhat unfortunate that the captions of two of these have been transposed.

J. A. Stephens

Basics of Induction Heating. *By Chester A. Tudbury.* (*Chapman & Hall—63s.*)

Although there is nothing new in the principles underlying induction heating (they were first observed by Faraday), the process has always been invested with an aura of mystery. Many text-books and instruction manuals have touched upon the subject, but this is probably the first volume devoted exclusively to the task of presenting the whole business of induction heating in a readily assimilable manner. The author claims to be addressing graduates, but at the same time takes great pains to spare the reader anything by way of even slightly advanced mathematics. This philosophy has its good points, of course, but one feels nevertheless that the serious student would welcome a somewhat more detailed analysis of some of the problems.

The book is divided into two volumes. Volume 1 deals with general principles, while Volume 2, after a hasty review of a.c. theory, enlarges upon the various types of equipment in current use, and their method of employment in induction heating. The merits and demerits of rival systems are very satisfactorily presented, and it is particularly pleasing to observe how the author makes it perfectly clear why certain machines or combinations of machines are used for particular applications. Indeed, the whole book leaves us with the feeling that Mr. Tudbury knows exactly what questions have been puzzling the uninitiated with regard to this subject—and very expertly he answers them.

The illustrations generally are of the type disparagingly referred to as "comic strip" on this side of the Atlantic. They are nevertheless very commanding in their instructional message, but we could do without the rather pointless and childish cartoons which embellish some of them; this sort of thing was considered necessary for the edification of the masses during the Second World War, but surely a graduate can manage without them?

M. Eades

OTHER BOOKS RECEIVED

The Antenna. *By L. Thourel.* (*Chapman & Hall—70s.*)

Translation based on a course given at the École Nationale de l'Aviation Circle, for use in planning an antenna system to specific requirements.

The Hall Effect and Related Phenomena. *By E. H. Putley.* (*Butterworths Publications—50s.*)

A semi-conductor monograph emphasising the evaluation of experimental data.

Bending Moments in a Plate and Girder System. *By C. C. Ritchie.* (*H.M.S.O.—4s.*)

The second of a group of research papers under the general title of "Studies on Bridge-deck Systems".

Semi-conductor Technology. *By G. K. T. Conn.* (*Butterworths Publications—10s. 6d.*)

Transcript of a series of articles previously published in *Research*.

Research on the Rolling of Strip. (*The British Iron and Steel Research Association—21s. to non-members of B.I.S.R.A.*)

A symposium of seventeen selected papers from the period 1948 to 1958.

Patent Abstract Series: No. 7, on ceramic, paper, rubber, textile, wood and other processes. (*U.S. Department of Commerce PB 111470, and supplement No. 2 PB 151512—50c.*)

A list, up to 1958, of Government-owned inventions available for license.

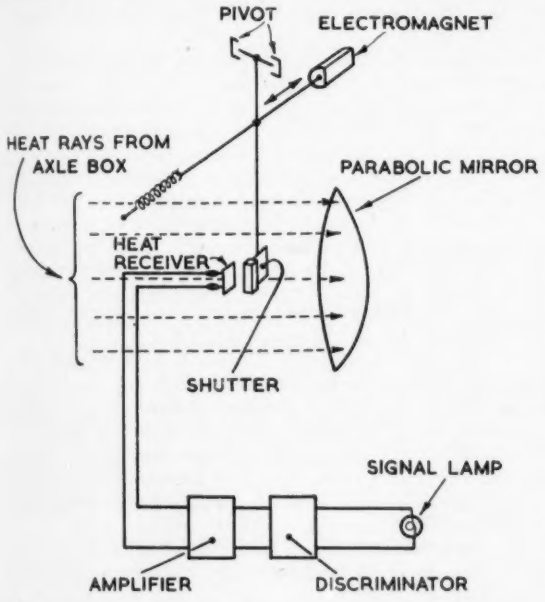
OVERSEAS NEWSLETTER

A monthly digest of reports from our foreign correspondents of other countries' current achievements in research and development work

Detecting Overheated Axle Bearings

A recent device invented by a German company (Siemens and Halske Aktiengesellschaft) can be fixed to the permanent way, and, irrespective of the speed of the train, can detect the presence of an overheated axle bearing by measuring the intensity of the heat rays emanating from the axle box.

A parabolic mirror concentrates the heat from the cover of the axle box on to a heat receiver, which may be a thermo-electric type of unit. Initially, this receiver is shrouded from heat sources by a shutter which is opened by an electro-magnet in response to an approaching train wheel. Due to the inertia of the shutter and the resilience of the rod carrying it, the lower part forms an oscillatory system. The amplitude of the oscillations is sufficiently



large to expose the heat receiver to the source of heat, the period of exposure being for an accurately determined period. The receiver generates a voltage impulse which is dependent upon the radiation, and which is amplified and compared by a discriminator with a predetermined value which can be set, for example, according to the ambient temperature. When this value is exceeded a signal is given by an indicator, which can be adapted to mark the affected axle. At the end of the electrical impulse initiated by the approaching wheel, the armature of the electro-magnet returns to its original position.

An Improved Tungsten-base Alloy

For applications requiring a high-density alloy having good machinability characteristics and high tensile strength, tungsten-based alloys containing nickel and copper have been used. Components made from this type of material are either cold pressed and sintered, or hot pressed, the latter process causing a lower shrinkage value and allowing less heavy and expensive presses to be used. Also, whereas a cold pressing requires steel dies, a hot pressing may be carried out in graphite dies.

There are, however, certain undesirable effects which occur when using graphite dies, one of which is a reaction between the pressing and the graphite resulting in a hard carbide coating being formed on the surface of the component. This reaction also causes adhesion between the die and the pressing, thus necessitating the destruction of the die in order to extract the component.

A new tungsten-base alloy developed by the U.S. Atomic Energy Commission contains a low percentage of nickel, and is claimed to overcome these disadvantages. This alloy contains about 2-3 copper, 1½-3 nickel and 4-6 per cent lead, an intimate mix being made while the constituents are in powdered form. Pressing is commenced at a low temperature, and is continued while the charge is being heated. The lead, having the lowest melting point, melts first, and probably forms a barrier between the charge and the graphite die, thus preventing the formation of a carbide coating. A test specimen of specific gravity 17·6, and containing 2 Ni, 3 Cu and 5 per cent Pb, gave a maximum fibre stress of 120,000 p.s.i.

Corrosion-resistant Coatings

The high resistance of titanium against many corrosive substances has already led to its use in many diverse industries.

A corrosion-resistant surface may be produced by projecting titanium balls by means of, for example, compressed air, against the surface to be coated; in this method, if a good coating is to be obtained, the angle of incidence must be considerably less than 90°. The surfaces so treated must be harder than titanium, since they will otherwise be damaged or distorted by this treatment.

It has also been proposed that titanium, and other high melting point metals such as chromium and molybdenum may be fused in a spray gun by means of an electric arc, and then projected in their molten state by means of compressed air, carbon dioxide or nitrogen.

However, with such methods it is impossible to produce adequate coatings which are resistant to corrosion, because during the fusion, and even more so during the projection, the metals react with the ambient air. The resulting layers, particularly those of titanium, consist substantially of compounds, especially oxides and nitrides.

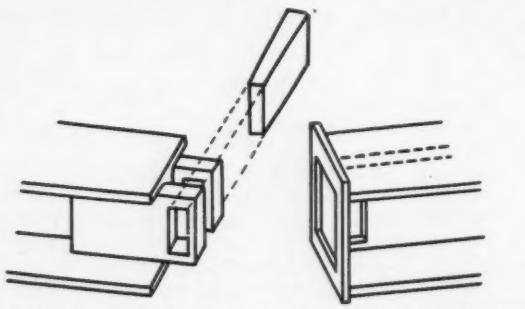
The object of an invention by Gebr. Böhler & Co. A.G., of Austria, is to carry out the metal projection system within an inert atmosphere, thus avoiding the risk of contamination during fusion, projection or solidification of the droplets. Titanium or titanium alloys are also suggested as coating materials; the first choice of an inert gas would be either argon or helium.

The corrosion-resistant coating applied by projection may be improved by subsequent cold polishing, this treatment being effected, for example, by cold rolling, hammering or ball-polishing. Its purpose is to reduce the surface exposed to corrosive attack as much as possible by making it completely smooth.

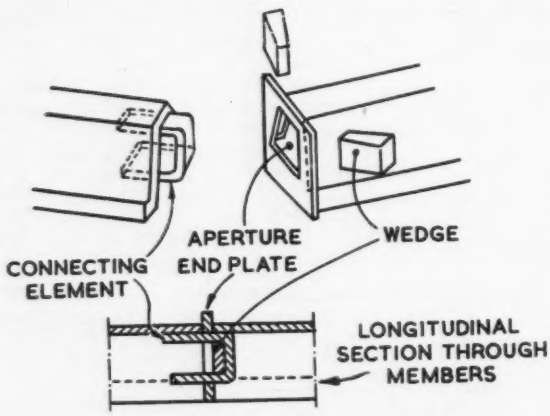
Joining Preformed Sections

A method of axially joining lengths of similar preformed sections has been suggested by Stahlschweisswerk Wartmann A.G., of Berne, Switzerland, and is likely to be of interest in view of the increasing use of preformed sections in many different industries.

In this invention, one end of a member to be joined carries an end plate containing an aperture, into which



METHOD APPLIED TO AN I SECTION MEMBER



can be fitted a connecting element rigidly attached to an end of the other member. When the two members are brought together, they are axially centralised by the shape of the connecting element and the aperture, and are held in position by one or more suitably shaped wedges driven through slots as shown by the examples above. The invention is protected by a British Patent (849,200).

Glass Fibre Reinforced Concrete

Two Russian scientists have been investigating, at Kiev, the possible use of glass fibre as a reinforcement for concrete. The experiments were conducted with alumino-borosilicate glass fibre and Portland cement, the glass fibre being used in the form of single-directional continuous three-ply twisted glass thread in lengths of 360 mm. The diameter of the elementary fibre was 5-6 μ, the ultimate tensile strength 327,000-355,500 p.s.i. and the elastic modulus 10×10^6 p.s.i.

Portland cement solidifies with dissociation of the alkali $Ca(OH)_2$, which was presumed to have a destructive effect on glass fibre, but it has been found that at temperatures between 20 and 40 deg. C. alumino-borosilicate glass fibre is not destroyed in an alkaline medium, the decrease of rupture load becoming significant only at higher temperatures.

In the light of experimental data on the behaviour of glass fibre in concrete, the employment of alumin-borosilicate fibre in concrete appears permissible without any protective measures against the effect of the alkali only when the fibre diameter exceeds 20 μ. Small-diameter fibre (6-7 μ and less) cannot be used as reinforcement in concrete without protective coatings, since an elementary fibre of relatively large surface and small cross-sectional area will be dissolved by $Ca(OH)_2$.

The strength of the glass fibre is also considerably affected by humidity, the chief factor in the destruction of a glass under load being the loosening-up effect of the reaction products of the glass with water—chiefly silica gel—an effect also observed during the action of water on glass fibre. Under a constant tensile stress, therefore, humidity will accelerate the destruction of the fibre.

With this in mind, further investigations were carried out with fibres bearing protective coatings in the shape of thin films of synthetic resins such as phenol formaldehyde, aniline formaldehyde, silicones and polyvinyl chloride. The quantity of the protective material amounted to 22-24 per cent of the weight of the fibre. No changes in the strength of the glass fibre reinforcement with protective coating were observed over periods of investigation of six, twelve and thirty months.

The concrete used in the investigation was compressed, using loads ranging from 7-7,000 p.s.i. The binding force increased rapidly when using a low pressure (up to 280-350 p.s.i.), and continued to increase with damping when the density of the concrete was further increased. The bond strength between bundles of fibres without protective coating and the concrete was smaller than for resin-coated bundles.

The maximum bond strength between fibre and concrete can be obtained by using glass fibre in the form of bundles or ropes which have been previously stretched under tension. Previous stretching of the reinforcement prevents the rapid reduction of diameter of the bundle or rope on pulling it from the concrete, and the bond strength between the glass fibre and concrete attains values of 1,020-1,065 p.s.i.

In the light of the experiments, the use of high-strength continuous glass fibre as reinforcement in concrete appears perfectly feasible. Of the reinforcements investigated, the most effective is in the form of pre-stressed glass fibre in which the "coefficient of utilisation" of the strength is 0·6-0·7 of the strength of the elementary fibre.

A comparative analysis of the specific strengths of fibre glass and of steel reinforcements showed that, even when utilising only from 60-70 per cent of the strength of the elementary fibre, the specific strength of pre-stressed glass fibre reinforcement exceeds the specific strength of a high-strength steel by a factor of 2·3, and the specific strength of another steel commonly used as reinforcement material by a factor of 15·5.

The ultimate strength of the fibre glass reinforcement depends on the uniform pre-stressing of all the components of its elementary fibres.

Boron Treatment

Thin layers of extreme hardness can be produced on steel or other metals by heat treatment in association with boron-containing agents. This hardness is maintained even after repeated tempering at up to 850 deg. C., and has a very high resistance to wear, with a resistance to corrosion that is better than that of the base metal, even at high temperatures. Brittleness presents a problem which may, however, be overcome by further development. The layer may be produced in thicknesses of 0·2 mm. within 4-6 hr. This period may be reduced to a few minutes by high-frequency heating at very high temperatures.

This research is being carried out at the Institut für Härtereitechnik, Bremen, Germany, and was the subject of a paper by Dr. Otto Schaaber, published in *Härterei-Technischen Mitteilungen*, 1, 44-48, Part B, 14-18.

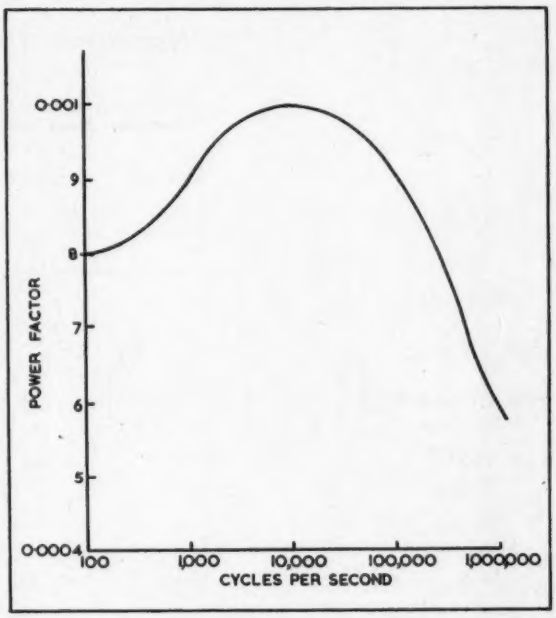
POLYPROPYLENE

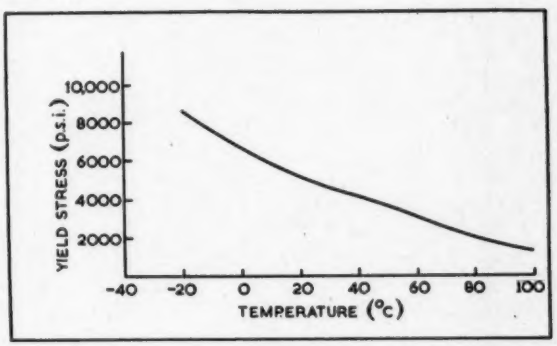
Engineering Materials and Design
DATA SHEET No. 56

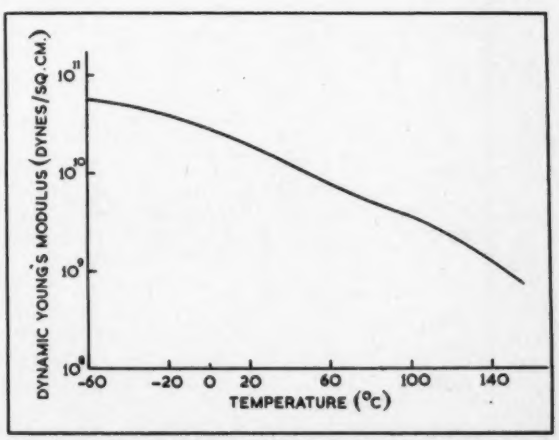
Polypropylene has a glossy surface, is available in a range of colours, and may be injection moulded and extruded using standard techniques. Extruded sheet can be vacuum formed, bent, cut, drilled, planed, punched or welded. Extruded tube for chemical plant, etc., is also available.

Polypropylene is the lightest commercial plastics available, and, since it has the highest softening point of the present polyolefin series, it is the most suitable of these materials for high-temperature service. In addition to having good electrical properties and excellent chemical resistance, it is the most rigid of the polyolefins; for example, its rigidity at 100 deg. C. is similar to that of low-density polythene at room temperature.

Property		Test Method
Specific gravity	0·905	
Weight per cu. in.	0·033 lb.	
Volume per lb.	30·6 cu. in.	
Melting range	165–170°C.	
Heat distortion temperature	105°C. at 66 p.s.i. 60°C. at 264 p.s.i.	D648-56
Specific heat	0·45 cal./gm.°C.	
Thermal conductivity	$3{\cdot}5 \times 10^{-4}$ cal. cm./sq. cm. sec. °C.	
Coefficient of linear expansion at 20°C. at 80°C.	11×10^{-5} per °C. 17×10^{-5} per °C.	
Ultimate tensile stress	5,000 p.s.i. at RT	D638-56T
Tensile yield stress (18 in./min.)	5,000 p.s.i. at RT 1,720 p.s.i. at 100°C.	D638-56T
Tensile modulus	170,000 p.s.i. at RT 37,000 p.s.i. at 100°C.	D638-56T
Elongation at yield (18 in./min.)	11–15%	
Ultimate elongation (0·2 in./min.)	220%	D638-56T
Flexural modulus	170,000 p.s.i.	D790-49T
Impact strength (Izod)	1 ft. lb./in. (notched) 33 ft. lb./in. (unnotched)	D256-56
Hardness (Rockwell R)	95	D785-51
Abrasion resistance (Tabor)	18–28	1044-54T
Dielectric constant	2·2 at 50 megacycles	
D.c. volume resistivity	$> 10^{17}$ ohm-cm.	
Power factor at 50×10^6c/s	0·0003	
Maximum temperature for dimensional stability	150°C.	
Moulding temperature	200–270°C.	
Moulding pressure	10,000–20,000 p.s.i.	
Mould shrinkage	1–2%	
Vicat softening point (1 kg.)	148°C.	DIN 57302







Data by courtesy of Imperial Chemical Industries Ltd. (Plastics Division).

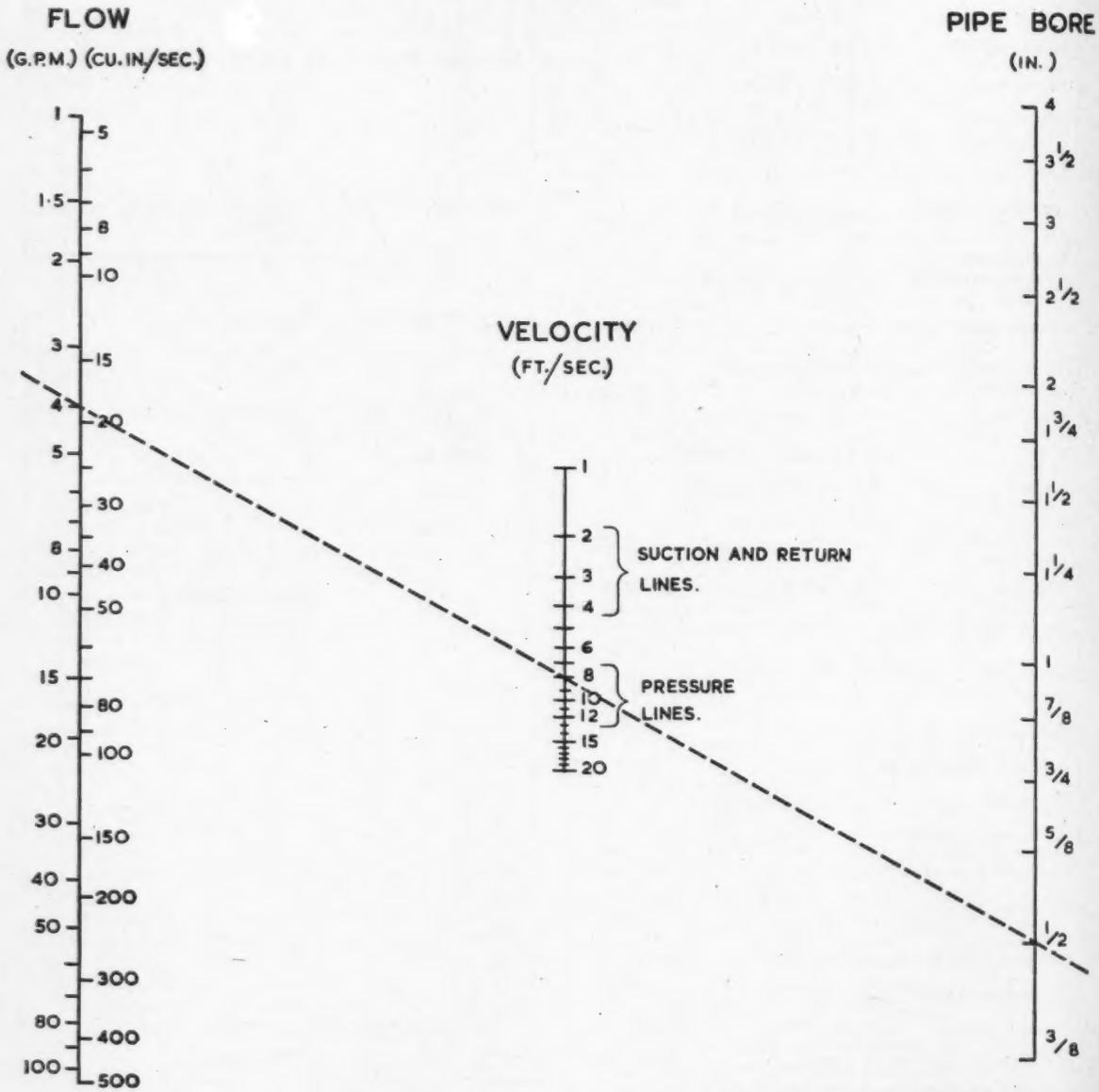
Nomogram for Pipe Capacities

This chart gives flow capacities for pipes at different velocities, based on the following formulæ:

$$\text{Bore (in.)} = \sqrt{\frac{\text{Flow (gall./min.)}}{2.04 \times \text{Vel. (ft./sec.)}}}$$

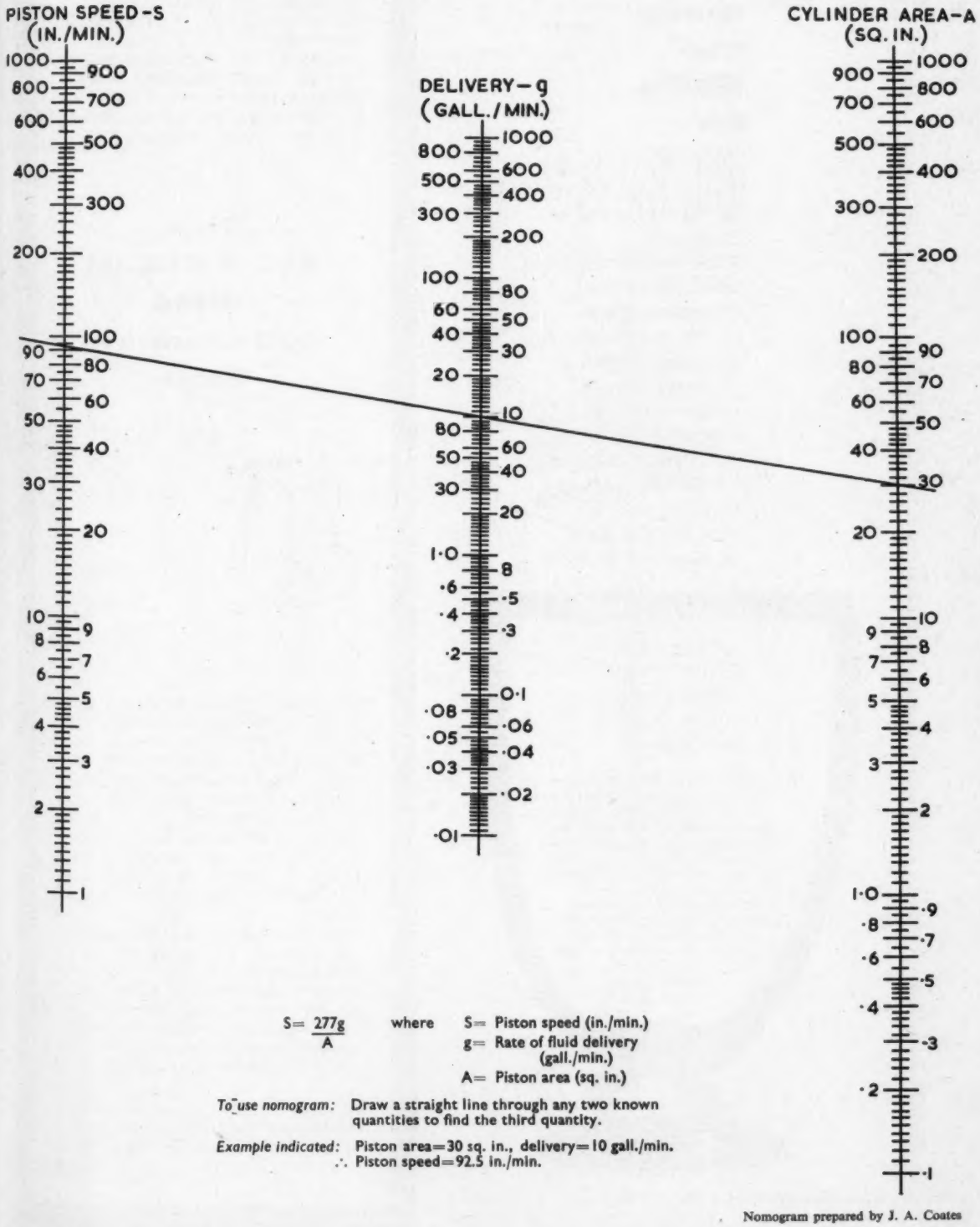
$$\text{Velocity (ft./sec.)} = \frac{\text{Flow (gall./min.)}}{2.04 \times \text{Bore}^2 \text{ (in.}^2\text{)}}$$

Recommended velocities for various conditions are indicated.



Data by courtesy of Pratt Precision Hydraulics Ltd.

Nomogram relating Piston Speed, Piston Area and Fluid Delivery



$S = \frac{277g}{A}$ where S = Piston speed (in./min.)
g = Rate of fluid delivery (gall./min.)
A = Piston area (sq. in.)

To use nomogram: Draw a straight line through any two known quantities to find the third quantity.

Example indicated: Piston area = 30 sq. in., delivery = 10 gall./min.
∴ Piston speed = 92.5 in./min.

Nomogram prepared by J. A. Coates

what helps to make the BEER so CLEAR?

Who makes a high-speed filter, for sloe-gin?
Or a reliable filter, for fast dye?
Who takes the bits, from bitumen and strains the sauce, at source?
In fact, who *really* makes a filter for *everything* that f-l-o-w-s?
In AUTO-KLEAN's literature

you'll find a filter for every fluid, together with a hundred-and-one applications . . .

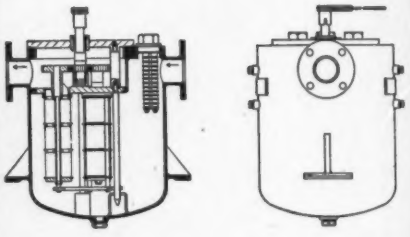
There's the world's first and finest range of fully automatic self-cleaning filters . . . as well as filters that combine the advantages of both paper and plate elements . . . magnetic filters . . . micronic filters . . . discharge filters—and many more. Quite a selection, and it goes on growing daily. That is why when you specify AUTO-KLEAN you can be sure of the best in modern filtration techniques

YOU CAN PUT YOUR TRUST IN AUTO-KLEAN

AUTO-KLEAN STRAINERS LTD. Engineers in Filtration
Lascar Works, Hounslow, Middx. Tel: HOUnslow 7722 (10 lines)

The 30M4 is specially recommended for all grades of oils. It can also be used, however, for distillates, water chemicals, beverages, paints, resins, pulp and industrial liquids of every kind.
Principle : Edge-filtration using four all metal plate-type filters. Three magnetic filters on the inlet side give added protection against micronic ferrous particles.

. . . This AUTO-KLEAN 30M4 self-cleaning filter



Advantages: (1) Full flow filtration. *All* the liquid passes through the filters to the *clean* side of the system. (2) Low pressure loss, ensuring high efficiency. (3) Self cleaning without dismantling or interrupting the flow. Two turns of the handle are all that is necessary. (4) Long life—lasts the life of the engine or plant. (5) Saves space and weight—large capacities relative to size.
Data: Handles up to 11,000 gallons per hour of lubricating oil in a defined mesh of 0.003″. Defined meshes range from 0.0015″ to 0.008″. Maximum working pressure 50 p.s.i. Steam jacketed designs for high temperatures are available.

Full details sent on request

A range of filters is also available for varying applications and flows up to 150,000 gallons per hour.

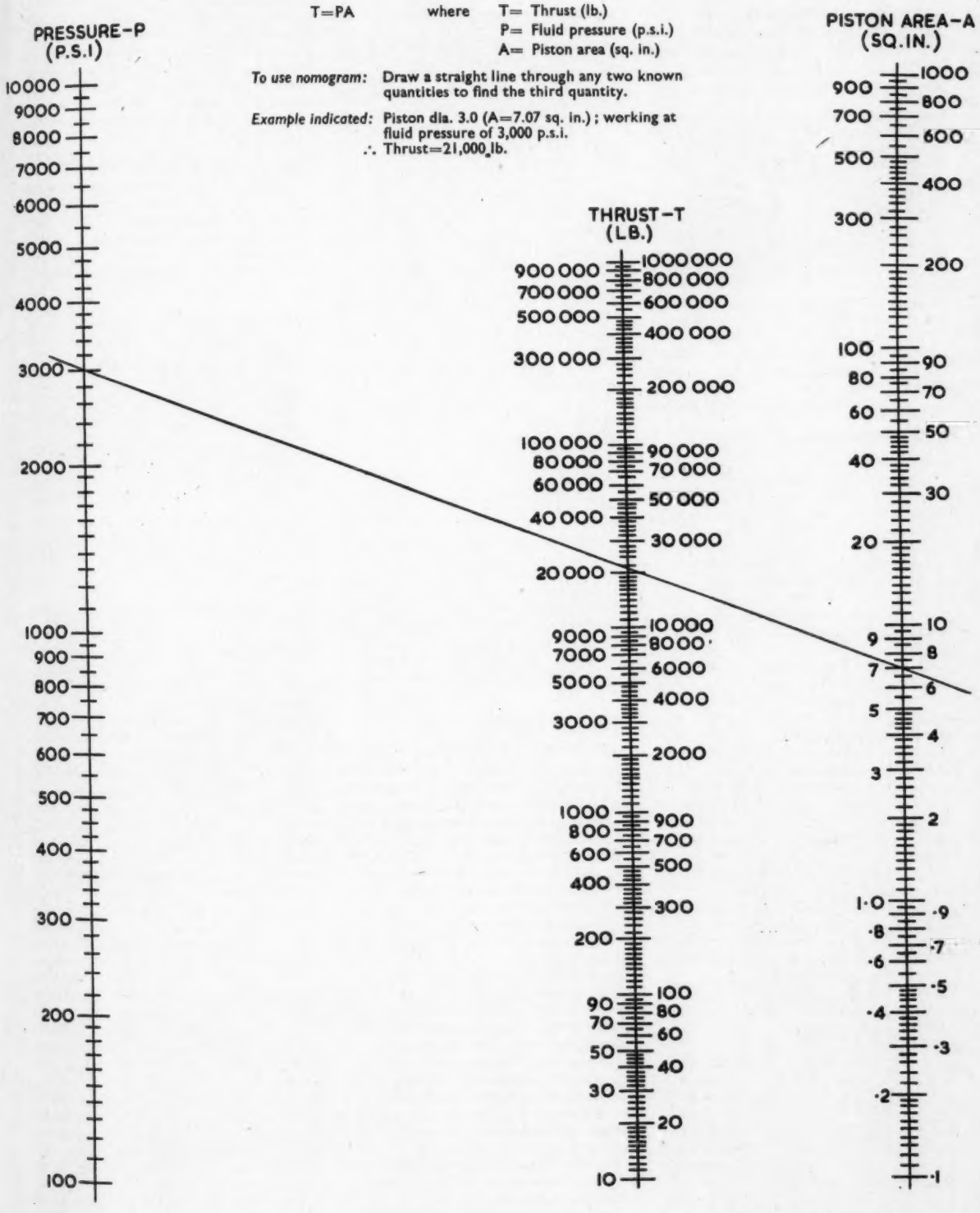
NOMOGRAMS FOR USE WITH THE SURVEY OF HYDRAULIC ACTUATORS (cont.)

Nomogram relating Piston Area, Fluid Pressure and Thrust

T=PA where T= Thrust (lb.)
P= Fluid pressure (p.s.i.)
A= Piston area (sq. in.)

To use nomogram: Draw a straight line through any two known quantities to find the third quantity.

Example indicated: Piston dia. 3.0 (A=7.07 sq. in.); working at fluid pressure of 3,000 p.s.i.
∴ Thrust=21,000 lb.



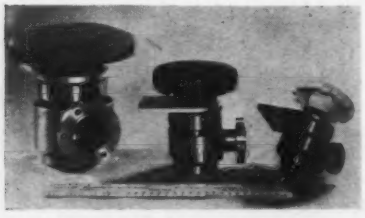
Nomogram prepared by J. A. Coates

Seen at the PHYSICAL SOCIETY EXHIBITION

HORTICULTURAL HALLS, LONDON, January 1961

Bakeable Ultra-high-vacuum Metal Closure Valves

A range of stainless-steel all-metal valves, bakeable to temperatures up to 450 deg. C. and employing valve faces of



hard stellite seating on to stainless steel, are available in ¼-, ½, 1- and 2-in. sizes. When closed, the valves have molecular conductances of the order of 10^{-9} litres/sec. Edwards High Vacuum Ltd., Manor Royal, Crawley, Sussex.

EMD 5963 for further information

Wide-range Pressure Gauge

This pressure gauge consists of a very thin aluminium ribbon supported between two clamps with a rectangular strip of metal plate behind, so that together the ribbon and the plate form a small capacitor. Any variation of the ribbon results in a variation of capacitance, which can be detected by conventional methods.

In the low-pressure range the ribbon is acted upon by molecules rebounding from a heated platinum strip placed a short distance away. However, since the force due to the pressure of radiation from the heated strip is equal to the molecular bombardment force at pressures of the order of 10^{-7} torr., it is impossible to separate these two effects in the normal type of Knudsen's gauge. In the particular gauge demonstrated, the molecular bombardment is interrupted periodically by a quartz chopper which allows the infrared radiation to pass without interruption. Thus the ribbon is given a constant deflection due to the radiation pressure, and a vibrating motion due to the interrupted bombardment. This motion may be detected with a capacity probe as in the high-pressure region, or by the e.m.f. generated by the ribbon in a magnetic field. It is theoretically possible to measure pressure down to 10^{-9} torr. by this method, and the upper limit is determined by the ratio of the molecular path length between the heated strip and the ribbon to the mean free path.

Over the high-pressure range the ribbon is made to vibrate by passing an alternating current through the ribbon in a magnetic field. The amplitude of vibration is then controlled by the acoustical damping of the ribbon, which is proportional to the pressure. When the gauge is operated in this way the measuring range is 10^{-2} to 10^{+3} torr. Mullard Ltd., Torrington Place, London, W.C.1.

EMD 5964 for further information

Non-ferrous Metal Sorter

This is a new type of portable instrument which enables instantaneous identification and sorting of non-magnetic metals to be carried out by unskilled labour. It differentiates between various alloys by indicating the difference in conductivity of a layer near the surface of the metal under test.

The patented feature of the instrument is that by a special circuit arrangement the sensing head has been made relatively insensitive to distance; i.e. unlike other instruments of this type, it will give a virtually constant reading even if the head is not kept absolutely square on the surface or if the surface is uneven. It will also give constant readings whether the surface is anodised or painted, or both.

It is not a precision conductivity bridge, but is normally used to identify specific materials when they have lost their identity marks, or to show the degree of heat-treatment. It will function with aluminium, magnesium and copper alloys, but must be reset for each basic metal. An application for which it has proved very useful is to indicate which side of Alclad is clad. Another use is to indicate the degree of heat-treatment of a particular alloy acting as a "go no-go" gauge in heat-treating processes. The instrument has also been used to differentiate between tantalum and niobium, between gold and its alloys, and between silver and its alloys. A slightly modified version has been evolved for use with titanium. Townson & Mercer Ltd., Beddington Lane, Croydon.

EMD 5965 for further information

Vibratory Polisher

The first British-designed and manufactured vibratory polisher is now available for specimen preparation. This unit, the Nashton polisher, eliminates the problems and time consumed by hand polishing and, due to its very gentle cutting action, is said to produce better specimen surfaces for metallographic examination. It can be left completely unattended —many users polish their specimens overnight. Up to eighteen specimens can be polished at one time, and any one or more can be removed for examination or replaced without affecting the others.

The cutting effect is achieved by the combined action of a powerful electromagnet which pulls the polishing table downwards, and the transverse table movement introduced by the three diagonal leaf springs. Due to the different rates of motion between the table and the specimens, the specimens are in effect carried forward with a slight turning movement.

The specimens, which are loaded with brass weights, rest on a tightly stretched nylon cloth impregnated with a suitable abrasive. The forward and rotary movement imparted to the specimens produces a very gentle cutting action. The minute degree of each movement of the specimens is controlled by the amplitude of vibration, which is set by adjusting one control knob. Nash & Thompson Ltd., Hook Rise, Tolworth, Surrey.

EMD 5966 for further information

High Coercive Force Magnets

Magnets of many shapes and sizes were displayed, with special emphasis on microwave applications such as high power isolators. One material shown in this category was Magloy 4. This is characterised by a relatively high coercive force of 1,100, which makes it ideal for

obtaining stopped magnetic fields of the kind now finding an increased application for focusing purposes in electronic devices. The Plessey Co. Ltd., Ilford, Essex.

EMD 5967 for further information

Moisture Gauge

This instrument has been developed to determine accurately the amount of moisture present in paper at any stage of operation of the paper-making machine. It is a non-contacting transistorised unit providing accurate measurements in the range 2-80 per cent of moisture content. Direct reading of moisture content is obtained on a meter scale of 7 in. dia. having an effective length of 270°. Alternative instruments can be supplied having scales calibrated from 2-15 per cent for "dry-end" working, or 55-80 per cent for "wet-end" working.

A "basis weight" control enables the instrument to be set up for the nominal weight of the paper being produced. Variations in basis weight within the order of ±5 per cent have negligible effect on the operation of the gauge. An output signal in the range 1-5 mA. is available for control purposes. Repeatability varies from approximately ¼-1 per cent at the low and high ends of the scale respectively.

An important application of this instrument is in conjunction with a standard Ekco beta gauge. The moisture gauge is directly coupled to the beta gauge, and operates as a compensating unit to enable true dry weight readings to be obtained continuously. Ekco Electronics Ltd., Ekco Works, Southend-on-Sea, Essex.

EMD 5968 for further information

Diffraction Gratings

A wide variety of diffraction gratings were shown for numerous applications, including spectroscopy, metrology, research and education. For infra-red spectrometry a range of gratings from 2-25 microns is available; this range is to be extended as new rulings become available. Standard gratings are on ¼-in. glass blanks, and all gratings are claimed to be flat to one fringe.

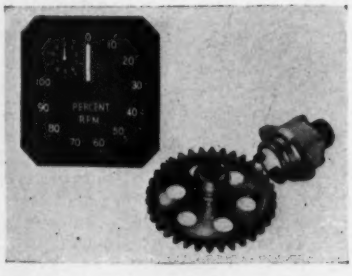
Radial gratings are available for machine control, and standard products made by photographic copy from original rulings are claimed to have a general accuracy of the order of 3-5 sec. maximum cumulative spacing error. A range of gratings for teaching requirements can be made of tough plastics mounted on plate glass. Paton Hawksley Electronics Ltd., Rockhill Laboratories, Keynsham, Bristol. **EMD 5969** for further information

Precision Tachometer

A precision tachometer which is claimed to have an accuracy of 0·1 per cent or better is said to abolish the need for a reduction gear between an engine and speed measuring element.

Basically, any toothed wheel within the engine is selected to produce an alternating voltage in the coil of an electromagnetic pick-off which is so mounted that the field of the magnet is completed via the teeth of the wheel. The resultant signal is fed to the presentation unit in which a voltage proportional to input frequency is obtained, and this is measured by means of a servo which also drives the indicator mechanism.

Manufactured to meet Ministry specification, the probe is said to be unaffected



by engine fuels or lubricants. Separate coils can be mounted on one frame if required to provide two or more electrically separate signal sources for indication and engine control. Apart from the advantage of requiring no moving parts, this system overcomes for the engine manufacturer the difficulty of designing a new gear train to provide 100 per cent at maximum speed when rerating an engine. The design of the probe is such that it is capable of operating under temperature conditions considerably higher than are permissible with conventional forms of tachometer generators.

By virtue of its flexibility, this system allows the adoption of any form of presentation. Percentage or direct r.p.m. indication can be provided, and, if required, an expanded limited range is possible over the power working r.p.m. Kelvin & Hughes Ltd., Wembley Park Drive, Wembley, Middlesex.

EMD 5970 for further information

Electroluminescent Panel

The Phosphotron Type P40 is an alpha-numerical electroluminescent panel intended for electronic data display systems. By simple switching, a single Phosphotron provides an inexpensive means of forming any of the decimal digits, the complete alphabet, and a number of other useful symbols, all of which appear at the same position in the panel. Thus each Phosphotron gives a bold and legible presentation of more than forty commonly used characters, any one of which can be displayed at will by switching the connections to the panel.

Constructionally, the Type P40 is a conventional electroluminescent panel with the back conductor divided into an array of sixteen strips, each having its own electrical connection brought out by a flying lead from the back of the panel. The panel itself is encased in plastics, with a glass front, and has three fixing holes for easy mounting. The characters formed are 4 in. high, so that the device can be read from distances of up to 200 ft. Ericsson Telephones Ltd., Beeston, Notts.

EMD 5971 for further information

Metal-ceramic Ion Pump

This device has been developed for high-vacuum work on special valves. The method of ionising gas particles and then absorbing them in order to reach a high degree of exhaustion is not new, but the outstanding feature of this pump is the all-metal and ceramic construction, which allows baking temperatures in excess of 600 deg. C.

The device is a hot-filament titanium-anode pump with a pumping speed of the order of 10 litre/sec. at 10^{-6} mm. Hg pressure, and is suitable for handling air and most other gases. The initial vacuum should be about 5×10^{-3} mm. Hg, whence the ion pump is claimed to exhaust to a pressure of better than 10^{-9} mm. Hg. E.M.I. Electronics Ltd., Hayes, Middlesex.

EMD 5972 for further information

Ultra-sensitive Electrical Recorder

The Sefram Graphispot is a unique instrument in that its recording head follows the movement of a light beam which is obtained by reflection from the mirror of a sensitive galvanometer. The recording head is servo-operated, and will follow the light beam at speeds up to 600 mm./sec. On paper 250 mm. wide, this means that a full amplitude signal at 1 c/s can be recorded. A wide range of paper speeds is available. The galvanometer sensitivity normally goes down to 0·25 microamp. f.s.d., and multi-range switching facilities are provided. Higher sensitivities can be provided to special order.

The equipment can also be used operating from an external light beam. In ordinary ambient lighting conditions, this light beam can be 3 m. long, and it is possible to record 1 micron of mechanical movement. Such measurements can be made on objects in vacuo or high pressure, or in low- or high-temperature conditions, with equal ease. Dobbie McInnes (Electronics) Ltd., 55 Kelvin Avenue, Hillington, Glasgow, S.W.2.

EMD 5973 for further information

High-temperature Heating Element

The Pyrotube is a new type of high-temperature heating element capable of heating furnaces to 1,800 deg. C. In this element a molybdenum heater is sheathed by a pure recrystallised alumina tube. The sheath, which is impervious, is sealed at the lower end and closed at the top by an appropriate header which contains electrical terminals and connections for the protective gas supply. Cylinder hydrogen is used at very small flow rates to prevent oxidation of the molybdenum, and is confined within the Pyrotube. The heated zone starts 3 in. from the bottom and extends upwards for 6 or 12 in. in the two standard types. These robust and easily replaceable elements can therefore operate in oxidising or reducing atmospheres, and the very low silica content (0·02 per cent) of the sheath eliminates contamination of the charge. They allow high-temperature furnaces to be built simply and inexpensively in a wide range of shapes and sizes. Metals Research Ltd., 91 King Street, Cambridge.

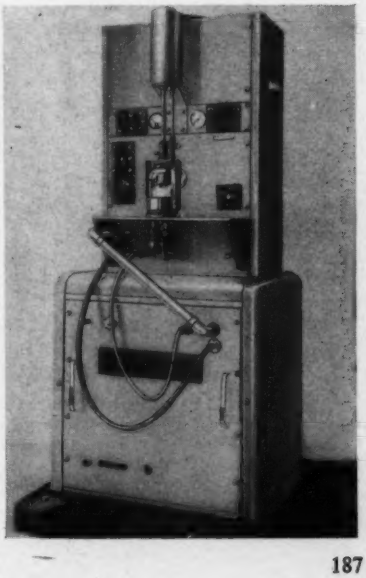
EMD 5974 for further information

Automatic Vacuum Resin-casting Equipment

A machine was shown for the automatic resin casting, under vacuum conditions, of components or assemblies. This unit comprises automatic sequence control as well as vacuum and pressure regulation. Pneumatic rams are used for the movement of the vacuum bell jar and the control of resin flow. The duration of a complete resin filling cycle with vacuum/pressure application is approximately 1 min., the vacuum being of the order of 100 microns.

The equipment is housed in two separate steel cases, which in operation are normally arranged one above the other. The lower case, mounted on a trolley, comprises the vacuum and pressure appliances, while the upper one contains the casting and control gear. G. V. Planer Ltd., Windmill Road, Sunbury-on-Thames, Middlesex.

EMD 5975 for further information



WHAT'S NEW IN MATERIALS & COMPONENTS

Corrugated P.t.f.e. Pipe

Corrugated p.t.f.e. flexible pipe, a recent development, provides an extremely flexible conduit, and is especially suitable for lightweight electrical harness and high-altitude breathing apparatus. Advantages claimed for this new flexible

pipe are indefinite shelf life, extreme flexibility, ability to withstand temperatures ranging from −70 to over 240 deg. C., and lightness. Palmer Aero Products Ltd., Herga House, Vincent Square, London, S.W.1.

EMD 5976 for further information

Fire-fighting Chemical

A new chemical hydrate emulsion called Slix, developed by the Research Group of the Penetone Co. in the U.S.A. and now manufactured and marketed in the U.K., is claimed to give 100 per cent effective safe control and immediate dispersal of inflammable spills on roads, airfields, dock basins, beaches, static water, etc. It contains no solvents, and is odourless, non-inflammable and non-toxic. It is said to be a highly penetrating, anti-coalescing agent which shatters the oil film into globules, chemically coating each droplet and isolating it with an area of non-combustible water of hydration. After application of a Slix/water solution, the spill is easily dispersed into drains and sewer systems with a stream of water. The Slix/spill emulsion is no longer inflammable, and the oil or volatile solvent will not be deposited on sewer walls, ships, dock pilings, etc. When applied as a coarse spray and agitated, it controls the vaporisation rate of petrols, etc., and prevents an explosive concentration of fumes forming. Penetone-Paripan Ltd., P.O. Box 10, Egham, Surrey.

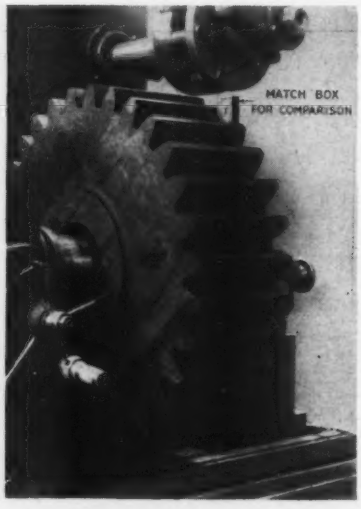
EMD 5977 for further information

Densified Wood

Lignostone is a material which in many ways bridges the gap between wood and metal. To make it, selected hardwood is physically and chemically processed to give complete uniformity of structure and greatly intensified mechanical strength, while retaining the best of the natural qualities. To meet the widely differing requirements of industry, many types of Lignostone have been evolved—these can be broadly described under two headings: Lignostone-Solid and Lignostone-Laminated.

Lignostone-Solid, while retaining the virtues of natural wood, is said to possess many mechanical properties only to be found in metal. The absence of laminations ensures great resilience and smooth even-wearing surfaces under the most exacting conditions. These factors make the material specially suitable for components subject to shock and frictional wear, such as bearings, textile shuttles and screen legs.

Lignostone-Laminated is a compressed wood manufactured from hardwood veneers fully impregnated and bonded with synthetic resins, the process of manufacture allowing uniformity of structure and controlled density. It is claimed to provide a dimensionally stable material, of great mechanical strength, which is highly resistant to moisture and possesses excellent insulating properties. (The accompanying picture shows a large gear made from this material.) By alternating the grain of the composite veneers



at 90°, equally in all radial directions, or in parallel, maximum strength may be obtained where specifically required. The Lignostone Co. Ltd., Church, Accrington.

EMD 5978 for further information

Improved Nickel Plating

The outdoor resistance of chromium-plated components can be substantially improved by using a dual coating of nickel beneath a chromium plate, the dual coating consisting of a deposit of semi-bright nickel followed by a deposit of bright nickel. The Efco-Udylite Bi-Nickel system, consisting of N2E sulphur-free semi-bright nickel followed by 66 bright nickel, is said to give good results in marine and mobile exposure and also in accelerated corrosion tests.

Ductility and freedom from pitting are two advantages claimed for the Efco-Udylite N2E deposit, which can be applied to any of the basis metals which are normally plated with bright nickel, such as suitably polished steel articles, copper-plated zinc-base die-castings, and brass components. High levelling, high lustre and good ductility are said to be characteristics of the 66 deposit, and the degree of adhesion obtained between the two deposits is excellent. The overall cost of the Bi-Nickel system is claimed to be lower than that of other dual nickel processes in current use. Electro-Chemical Engineering Co. Ltd., Sheerwater, Woking, Surrey.

EMD 5979 for further information

P.v.c.-Hycar Cable Sheathing

Cables clad in a new sheathing material made from a blend of Geon p.v.c. and Hycar nitrile rubber are now being produced by Greengate & Irwell Rubber Co. Ltd. This Niplas sheathing has been used on trailing cables, welding cables and flexible power cables, such as for supplying power to crane electromagnets.

Niplas sheathed cables, with suitable forms of insulation, have shown a number of advantages over other conventionally sheathed types. The nitrile-based sheathing is said to withstand temperatures up to 85 deg. C., and to have good mechanical properties, good oil, solvent and fire resistance, and excellent abrasion resistance (particularly important for welding and trailing cables). Furthermore, the p.v.c. content of the material enables Niplas sheathed cables to be manufactured in a variety of bright colours without loss of mechanical strength, and also enhances grease resistance—cables can remain smeared with grease without deterioration. British Geon Ltd., Devonshire House, Piccadilly, London, W.1.

EMD 5980 for further information

Filler for Epoxy Resin

Econyfill fillers are recommended for use with epoxy resins, mainly because they are a convenient inert filler of controlled size with reasonable dielectric loss and low thermal expansion coefficient. The material is spherical, is said to flow freely, and can be added to the casting mould before the resin, which is subsequently poured in as part of a vacuum-impregnation process. This method gives the advantages of a highly filled resin without the difficulties involved in handling a high viscosity mix. The English Glass Co. Ltd., Scudamore Road, N.P.E., Leicester.

EMD 5981 for further information

FOR MORE INFORMATION
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WHAT'S NEW IN MATERIALS & COMPONENTS

Anti-corrosion Lining

A new industrial anti-corrosion lining, consisting of a composite laminate of polythene or polypropylene on rubber, has been developed to enable synthetic plastics to be applied direct to metal for tank linings. The new laminate consists of a layer of either polythene or polypropylene bonded chemically to a rubber backing layer by a patented process. The linkage is said to be extremely strong. The laminate is applied to metal surfaces using the rubber backing as a bonding layer, which also serves the dual purpose of accommodating expansion differentials between the polythene/polypropylene and the metals.

Another of the newer additions to the rubber lining range is Hypalon lining. This is said to be particularly suitable for use with medium-strength oxidising acids, and at higher temperatures than any other rubber lining material. It is extremely resistant to sunlight and ozone, and has good resistance to most acids, alkalis and salts. Dunlop Rubber Co. Ltd., 10-12 King Street, London, S.W.1.

EMD 5982 for further information

Plastics Foil for Vacuum Forming

A new product called Novon 504 has been successfully vacuum-formed over cabinets which were hitherto covered in leathercloth by hand. This process is said to be cheaper and faster than the old method. The new material is a thermoplastic foil supplied already coated with a suitable adhesive.

In the vacuum-covering process, working temperatures in excess of 120 deg. C. are normal, and radio cabinets are often subjected to high temperatures in window displays. It is claimed that such conditions do not impair the properties of Novon 504 foil, which retains its original

surface texture when it has been secured to the cabinet; it is available in a range of attractive colours, and has a highly abrasion-resistant finish. (The photograph shows a handbag-style Murphy portable wireless, the top and base of which have been covered in Novon 504 by a vacuum process.) Imperial Chemical Industries Ltd., Imperial Chemical House, Millbank, London, S.W.1.

EMD 5983 for further information

Low-temperature Aluminium Joining

AutoChemic 990 is a specially formulated paste compound which is claimed to give high-strength corrosion resistant joints on virtually all types of aluminium and aluminium alloys, and to require no finishing or after-treatment. No filler alloy is required. The compound is merely painted on where required, thus facilitating preplacement on multiple or production joining applications, and giving great economy in use.

990 is recommended for all fine work, such as wire and cable joining, instrument parts, cans, small wave guides, floats and other small fabrications. A neat fillet easily cleaned in warm water is produced by applying the compound and heating indirectly. A series of chain-type reactions takes place, terminating in metallic reduction at the reaction temperature of 400 deg. C. Eutectic Welding Alloys Co. Ltd., North Feltham Trading Estate, Faggs Road, Feltham, Middlesex.

EMD 5984 for further information

Furnace Brick Sealant

Coltrate 1436 is a material that has been specifically designed to seal the external brick settings of furnaces. It is well known that if brick settings and catwalks are for any reason unsealed, cold air will penetrate. Bricks themselves are porous, and allow cold air to be sucked through. This flow of cold air is unseen, but is made evident to the steam engineer by a significant fall in the CO_2 value. The use of Coltrate 1436 is said to result in a greater CO_2 content in flue gases, and much lower fuel costs.

This material can also be used over the lagged crowns of drum-type boilers, to make good existing cracks and prevent any further cracking. It is simple to apply straight from the drum, using a float trowel, and is claimed to be sufficiently elastic to move with the brick settings through any change in temperature. Coltrate Ltd, Warsash Road, Warsash, Hants.

EMD 5985 for further information

Double-sided Tape

A new double-sided adhesive tape, Twinstik, consists of a thin tissue impregnated with a special pressure-sensitive adhesive and protected by a treated paper. It is available in a variety of widths up to 12 in. and can be applied to most surfaces to give a strong and durable bond.

The cohesive strength provided, combined with the excellent ageing properties, transparency and light resistance, are said to make this pressure-sensitised tape of considerable value in the manufacture and assembly of products in industry. The absence of solvents on the adhesive surfaces makes the tape suitable for use on cellulose and other finished surfaces. Evode Ltd., Stafford.

EMD 5986 for further information

Zippertubing

Zippertubing is a flat tape, available in a wide range of materials to meet various environmental conditions, that has a specially extruded plastics beading electronically welded to both edges. The tape is wrapped around the conductors

to be jacketed so that the beading matches, then zipped shut to form a high quality sheathed electric cable. Special jacketing is also available for covering pipes and conduits. Hellerman Ltd., Crawley, Sussex.

EMD 5987 for further information

Powder for Pipe Protection

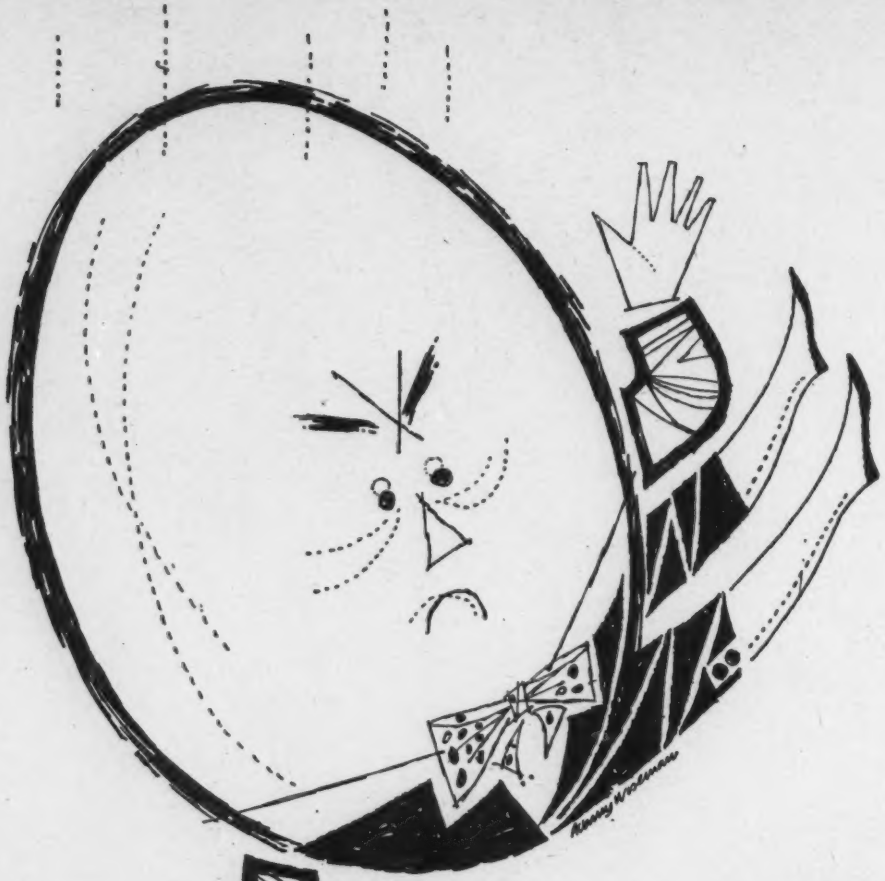
Protexulate is a fine mineral powder, prepared by a patented process, which has been developed for use in underground pipe installations. It is said to provide an efficient thermal insulation and complete protection from corrosion for buried heating pipes. In addition, the overall cost is claimed to show great economical advantage over other methods of installation. It is also claimed that Protexulate is permanently waterproof, that its free-flowing condition is maintained indefinitely, and that, although impermeable to moisture, it allows the pipeline to "breathe". The thermal conductivity of the powder is said to be as low as 0·912, dependent upon the temperature, and it can be used for conduits with temperatures up to 250 deg. C. Croxton & Garry Ltd., 16-18 High Street, Kingston-on-Thames, Surrey.

EMD 5988 for further information

New Epikote Resin

Epikote 817, a medium-viscosity plasticised epoxide resin, has been added to the Epikote range. The inclusion of a plasticiser in the resin results in a reduced exotherm during reaction, and also gives an increase in the "pot-life" of the system compared with other Epikote resins. 817 is therefore particularly useful for electrical work where cure must be effected at or near room temperature. The plasticiser imparts a certain degree of flexibility to the cured product which serves to resist cracking due to thermal stresses. The new grade is also useful for laminating applications, due to its longer "pot-life" at room temperature. Shell Chemical Co., 170 Piccadilly, London, W.1.

EMD 5989 for further information



what's his kinetic energy?

Humpty may know that KE = W × h
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But wherever the formula does apply—e.g. in design
of components that have to survive much handling—
fragility can be reduced in the simplest way.
Magnesium has one of the highest
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stiffness without weight penalty, offers lightness
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Clifton Junction Manchester *Swinton 2511*
London Office : 5 Charles II Street St. James's SW1 *Trafalgar 1646*
Magnesium Elektron, Inc., New York 20, USA

WHAT'S NEW IN COMPONENTS

New Mechanical Shaft Seal

A new mass-produced precision unit mechanical shaft seal has just been introduced. There are two versions—types 106 and 106A. The former is for applications such as fuel-oil, hydraulic and other positive displacement pumps, deep and shallow well jet pumps, refrigeration compressors, small centrifugal water pumps, agitator shafts, etc. Type 106A is a press-in version of the 106 seal, and was first designed to provide a low-price highly efficient seal for the water pumps of motor cars. This version of the seal is also suitable for a wide range of domestic appliances.

The size range of the 106 seal is ½, ⅝, ¾ and 1 in., and that of the 160A ½, ⅝, ¾ and ⅞ in. Both seals are designed for service at pressures up to 75 p.s.i. and temperatures up to 100 deg. C. Crane Packing Ltd., Slough, Bucks.

EMD 5990 for further information

Controlled Strip Oiler

The new Clark oiler is designed for the accurate cleaning and lubrication of strip

before feeding into power presses. Its mechanism consists of a side opening box containing freely rotating felt rollers. Individual needle valves control the amount of lubricant fed from a storage bottle to the core of the rollers, and rubber squeegees mounted at the point of entry clean the material as it passes. The storage bottle is refilled by opening the top half of the box to an inverted position, when the bottle can be removed or replaced, without spilling.

Uses other than lubrication are the application of degreasers or thinners, prior to follow-on operations on strip materials. The unit incorporates fixing facilities which make attachment to press bed or automatic press feed a simple task. Clark's Press Equipment Ltd., West Drayton, Middlesex.

EMD 5991 for further information

New Screw Anchors

The Expandet screw anchors, now available in the U.K., enable wood screws to be fixed in brick, masonry, etc., without the shortcomings normally associated with this type of product. Made of plastics material, they are claimed not to fray on being driven into position. They consist of an extruded sleeve, of the cross-section illustrated, which expands into the drilled hole as the screw is inserted. They are said to be unaffected by chemicals in

normal circumstances, and to have exceptional bearing power and adhesive capacity. If the Expandet is found to be too long, it can be cut with a pair of pliers or a knife. It is available in a range of eight colours. Expanded Plugs Ltd., 9-10 College Hill, London, E.C.4.

EMD 5992 for further information

Iris-diaphragm Control Valve

A new type of regulating valve makes use of the iris-diaphragm principle, and overcomes one of the main disadvantages of other types of valve by ensuring that the orifice is always symmetrical to the flow axis. The advantages of this type of valve are that it prevents clogging when solids are present, and cavitation effects are minimised.

The diaphragm segments are designed to provide a valve which is self-cleaning in either direction of flow. Indicators pro-

vided with these valves give a precise reading of the percentage of the cross-sectional opening. Materials of construction include all the common metallic materials, including the austenitic steels and nickel alloys. Sizes, of which there are seven, range from 25-250 mm. Moffat & Bell Ltd., 170 Piccadilly, London, W.1.

EMD 5993 for further information

Photo-cell Unit

A photo-cell unit that will operate only when the light beam is interrupted in one direction is announced. Should an object pass through the beam in the reverse direction, nothing happens. A warning system, incorporating the unit, is also announced which gives an audible or visible alarm when a change occurs.

The warning system can be used to monitor moving webs of any material, including paper, polythene, rubber and steel, and immediately indicates when a break or tear occurs or a required loop disappears. In other applications it will show when persons or objects pass a fixed point, or will act as a height or level gauge. The warning can be set on site to sound continuously, or to stop ringing after five to 15 sec. The equipment is suitable for operation indoors, or outside under wide temperature variations, and can be used in smoky conditions. It is suitable for beam lengths of up to 75 ft. A range of recorders is available to record times of breakage, etc. Several beams can be connected to a single control unit. Hird-Brown Ltd., 244 Marsland Road, Sale, Cheshire.

EMD 5994 for further information

Plug-in Latching Relay

A new latching relay with electrical release is a bi-stable or "memory" unit, since a short pulse to the main coil results in a change in the contact positions that persists until a pulse is given to the release coil. Both coils are continuously rated, and can be operated from d.c. or a.c. Up to three change-over contacts or five pairs of make-or-break contacts can be fitted, and all materials, including the transparent cover, are non-inflammable and fully tropical.

Also available are: a latching relay with manual reset; relays with magnetic blow-outs that can switch inductive loads even on d.c. mains; plug-in time delay units; flasher units; and pulse-producing relays. D. Robinson & Co. Ltd., 717 London Road, Hounslow, Middlesex.

EMD 5995 for further information

Please Note!

We receive many reader enquiry cards on which the reader has omitted to fill in his name and address. In order to avoid disappointment we remind readers that names and addresses should be included on each card.

EMD 5867 for further information

THIS IS NOTHING TO WHAT GOES ON INSIDE A

BULLOWS NOPUMP

SPRAY BOOTH

ALMOST ENTIRELY ELIMINATES MAINTENANCE

NO PUMP
NO FILTERS
NO PIPES
NO NOZZLES

In this new type of Water-Wash Spray Booth the exhaust air travels at very high velocity over the water surface entraining water. The air/water mixture, moving through controlled changes of direction, provides the scrubbing action.

★ **A NEW PATENTED PROCESS OF WATER TREATMENT...** **substantially increases the efficiency of these Booths.**

NO CLEANING OUT AFTER 1 YEAR'S CONTINUOUS DOUBLE-SHIFT WORK AT

Massey-Ferguson
(UNITED KINGDOM) LTD.

STRETFORD · MANCHESTER

This Booth was started up on production on 1st March, 1959, and has operated two nine-hour shifts on continuous painting of agricultural machinery. When last examined, there was an average depth of silt of 6 inches over the entire water tank bottom, an area of 290 sq. feet. A further 4 inches, making 10 inches in all, can be accommodated before cleaning is essential. After 1 year's operation, the fan and ducting were barely discoloured, the only maintenance cost being cleaning the floor inside the booth, routine greasing of bearings and similar preventive maintenance.

VISITS TO FACTORIES WHERE BULLOWS' NOPUMP SPRAY BOOTHS HAVE BEEN INSTALLED CAN BE ARRANGED ON REQUEST. WRITE TODAY FOR FULL DETAILS OF THIS OUTSTANDING BULLOWS' ACHIEVEMENT.

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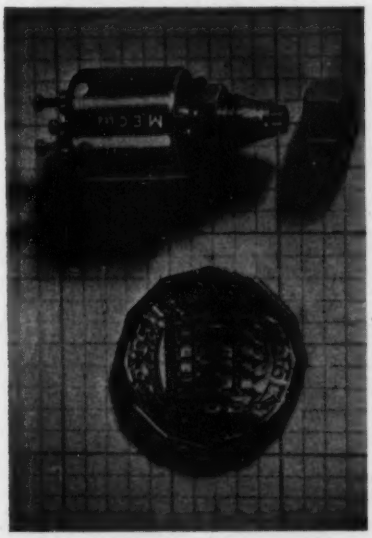
61-63 DRURY ST., DUBLIN. TEL: DUBLIN 73188/9
BULLOWS (AUST) PTY. LTD., ETHEL AVENUE, BROOKVALE, SYDNEY, AUSTRALIA

WHAT'S NEW IN COMPONENTS

Miniature Rotary Potentiometer

The TP5 single-turn miniature potentiometer has been specially developed for the aircraft and guided weapons industries. Its compact construction is illustrated by comparison with a threepenny piece, maximum diameter being 0·5 in. and overall length 1·14 in.

This potentiometer is capable of dissipating 1½ W. at 80 deg. C., has a temperature range of −55 to +150 deg. C. and is available in ten standard values



ranging from 50 to 50K ohms. Fully sealed against climatic variation, it is claimed to maintain consistent performance under the most severe environmental conditions of vibration and acceleration. Miniature Electronic Components Ltd., The Lye, St. Johns, Woking, Surrey.

EMD 5996 for further information

Miniature Capacitors

Two new Silver Star capacitors, types A15E and A25E, are square in section, of very small size, and designed specifically for transistorised printed circuitry. The components are encapsulated in synthetic resin.

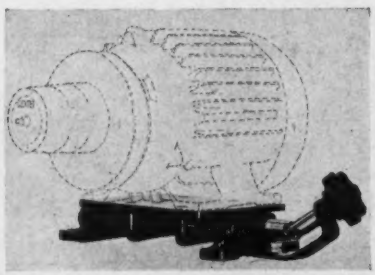
Type A15E is ¼ in. square by ½ in. long, and has a capacitance range of 33-6,000 $\mu\mu$F (minimum tolerance ±2 per cent, or ±2 $\mu\mu$F below 100 $\mu\mu$F). A25E has the same section but is 1 in. long, with a capacitance range of 6,000-20,000 $\mu\mu$F (minimum tolerance ±1 per cent). Any capacitance value within these ranges can be supplied. Both types are rated at 50 V. peak working.

Although the leads emerge axially they can be readily adjusted to fit 0·1 or 0·2-in. module printed circuit boards. The square section permits the cementing of the capacitors to the printed circuit boards if acceleration forces are high. Fired construction is used to ensure maximum long-term stability, while strict control over the mica and manufacturing processes is said to ensure a consistently high insulation resistance and low power factor. Johnson Matthey & Co. Ltd., 73-83 Hatton Garden, London, E.C.1.

EMD 5997 for further information

"Low-loader" Motor Base

The new Low-Loader traversing motor base has been designed for use with the Sextet variable-speed drives. The overall height of the base has been reduced by



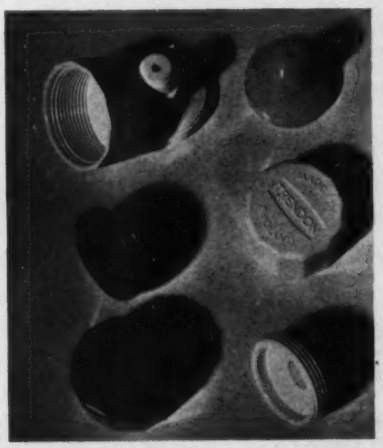
half, thus enabling complete drives to fit neatly into modern streamlined machines, and to be installed in hitherto inaccessible spaces. Alternative hand-wheel controls can be fitted to the bases, so as to provide either control in remote positions.

The bearer blocks and slide bars have been redesigned to provide maximum bearing contact, and to enable the motor plate to traverse smoothly with minimum effort when carrying even the heaviest electric motor. The motor plate can be removed easily from the base to simplify the drilling and fitting of the motor. Industrial Drives Ltd., 105 Uxbridge Road, Ealing, London, W.5.

EMD 5998 for further information

Lubricators in Plastics

Stauffer screw pressure lubricators are now moulded in Maranyl I.C.I. nylon, and are available in a standard range of five colours. Grease points can now be highlighted, and colour coding for maintenance schemes has become possible.



The lubricators have a diameter of 1½in. and a capacity of ½ fl. oz., with a standard nipple connection of either ¼ or ⅛ B.S.P. Trendon Ltd., Malton, Yorks.

EMD 5999 for further information

Automatic Lighting Controller

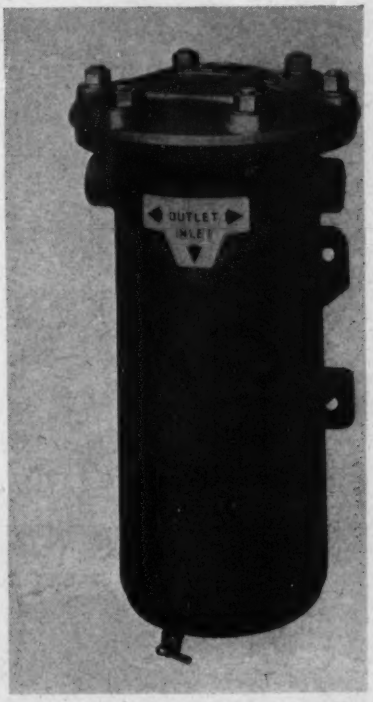
An automatic lighting controller which switches on artificial light when the natural lighting fails, and switches it off again when the natural lighting resumes, is being manufactured and marketed by Electrical Distributors. The controller is adjustable to any level of daylight, and is suitable for use with street, shop, factory, office, hotel and hospital lighting, and safety lights and signs. It can also be used for operating such equipment as shop blinds. Electrical Distributors, 11 King Edward Buildings, Bury Old Road, Manchester, 8.

EMD 6000 for further information

Charcoal Filters for Air Systems

For use where oil in the air stream is not acceptable, and also for eliminating the smell of oil, a range of activated charcoal filters has been developed. Each filter consists of an outer case and lid with a cartridge of activated charcoal, and conforms to British Standards where applicable. Provision is made on all filters for four-point wall mounting.

The cartridge of activated charcoal removes oil from the air stream by adsorption, and is therefore an expendable item



which requires changing at intervals, dependent upon operating conditions. An average normal life of a cartridge element is 1,000-1,500 working hours. Cartridge replacement is claimed to be quick and easy. Air inlets are located in the bottom and air outlets at the side of the filters, so that when changing the cartridge it is not necessary to break the air connections. The lid, which is sealed with an O-ring, is removed, the cartridge changed and the lid replaced. The available range of these filters caters for outputs from 3-120 c.f.m. Alfred Bullows & Sons Ltd., Long Street, Walsall, Staffs.

EMD 6001 for further information

EMD 5868 for further information

When did *you* last see a Dutch interior? Never mind! The point is that there's an art to protecting the interiors of tanks. And Ensecote has it. *Any* size of tank. *Any* sort of liquid practically. Ensecote protective linings are easily cleaned and sterilized; completely odourless, tasteless, and economical to install (larger vessels can be lined on the spot). Ensecote protective linings add years to a tank's life.

ENSECOTE *Lithcote* PLASTIC LININGS

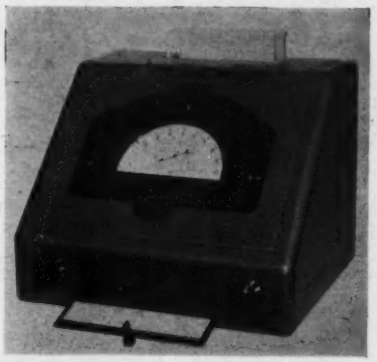
For literature and technical advice on linings, and on tank fabrication, write to: NEWTON CHAMBERS & CO. LTD., THORNCLIFFE, SHEFFIELD, ENGLAND

Agents in Belgium, France and Holland: FOURS LECOCQ ET ATELIERS DE TRAZEGNIES REUNIS, S.A., TRAZEGNIES, BELGIUM

WHAT'S NEW IN EQUIPMENT

Moisture Meter

The rapid and accurate determination of moisture content in a wide range of materials is said to be possible using the Kappa moisture meter (model AB/55). This instrument is a frequency-sensitive device that measures, in arbitrary units,



the permittivity of the contents of a removable test cell, the permittivity being dependent upon the physical properties and moisture content of the material. A change in frequency produced by a variation in the moisture content of the sample is accurately detected by a superhetrodyne circuit, and indicated on a continuous scale that is calibrated in 1,000 divisions.

The frequency of the test circuit is selected so that readings are not affected by conductivity, and a choice of cell size ensures that the sample is truly representative of the bulk. For normal materials of reasonably constant composition texture, the accuracy is claimed to lie between 0·05 and 1·0 per cent, depending on the moisture range. Typical applications are the determination of moisture content of grain, cork, tobacco, cocoa, coffee, tea, sugar and biscuits. Kappa Electronics, Division of Fidelity Cars Ltd., 159 Hammersmith Road, London, W.6.

EMD 6002 for further information

Torque-controlled Screwdriver

A new torque-controlled screwdriver and nutrunner (the CP 3008-LMS-1600), incorporating a Magnamatic clutch, has been introduced to meet the demand for a tool which will eliminate damage such as stripped threads and distorted workpieces due to application of excessive torque during the tightening of screws and nuts.

The new screwdriver uses a new magnetic clutch which is formed by a magnet being housed inside a pair of mating, cylindrical jaws. At one end, the jaw cylinder is tapped to accommodate the threaded shank of the cylindrical magnet which fits inside the jaws, while a steel disc is located at the other end of the cylinder. The jaw teeth are curved tooth shaped, the depth to which these interlock being governed by the number of turns made in the magnet shank. In operation, the torque required to separate the two jaws depends upon the depth of engagement. When the required torque value is reached, the jaws disengage, the lower jaw being held out of engagement by a latch which is released when the tool is withdrawn from the work.

The 3008-LMS-1600 is equipped with a lever handle, and has a nominal capacity screw size range from No. 4 to No. 8. The range of torque adjustment is from 5-20 in.-lb. on soft pull-up work, while on free-running sudden-stop work the maximum torque value is 40 in.-lb. The overall length of the tool is 10 in., and the net weight 1 lb. 14 oz. The air inlet thread size is ¼ in. Consolidated Pneumatic Tool Co. Ltd., 232 Dawes Road, London S.W.6.

EMD 6003 for further information

Audio Thickness Gauge

A new type of instrument designed specifically for measuring the thickness of sprayed zinc and aluminium coatings is said to enable large areas to be checked rapidly. The principle of its operation is based upon an exploring head which may be moved quickly over the coated surface. The instrument can be set to indicate any minimum thickness, and gives an audible

warning of areas which are below this required thickness. Accurate test specimens are used to set the gauge to any desired thickness between 0·002 and 0·012 in.

The set is completely portable and fully transistorised, and the miniature operational battery has a life of over four months. It is claimed to be unaffected by magnetic fields or stray magnetism. Although the present exploring head is made for flat surfaces only, adaptors are now being designed to enable the unit to measure curved surfaces and tubes. Metallisation Ltd., Barclays Bank Chambers, Dudley, Worcs.

EMD 6004 for further information

Cutting-off Machine

The Cefmo AC.85, a metal cutting and circular sawing machine, is designed to make clean and economical cuts on all kinds of tubes and bars. It has a 360° turntable which allows for any degree mitre cut without moving the works, and adjustable back plates to give full support to the workpiece at either side of the blade, thus facilitating burr-free sawing.

The 12-in. H.S.S. saw blade rises from below the table, cuts mitres without run-out, and allows for maximum use of the saw blade diameter for slotting, etc. The saw head travels on the centre column, giving straight cuts each time. The Addison Tool Co. Ltd., Addison House, 28 Marshalsea Road, London, S.E.1.

EMD 6005 for further information

Analysing Structural Stresses during Design

A new low-frequency spectrum analyser is designed to enable advance information to be obtained of vibrations, strains and resonances in structures by analysing their waveforms. Its purpose is to eliminate many of the trial and error techniques which are necessary when building a prototype. It has been designed for specific applications with aircraft structures and is supplied with recording equipment and all necessary auxiliaries. Fenlow Electroniques Ltd., Weybridge Surrey.

EMD 6006 for further information

Infra-red Drying Unit

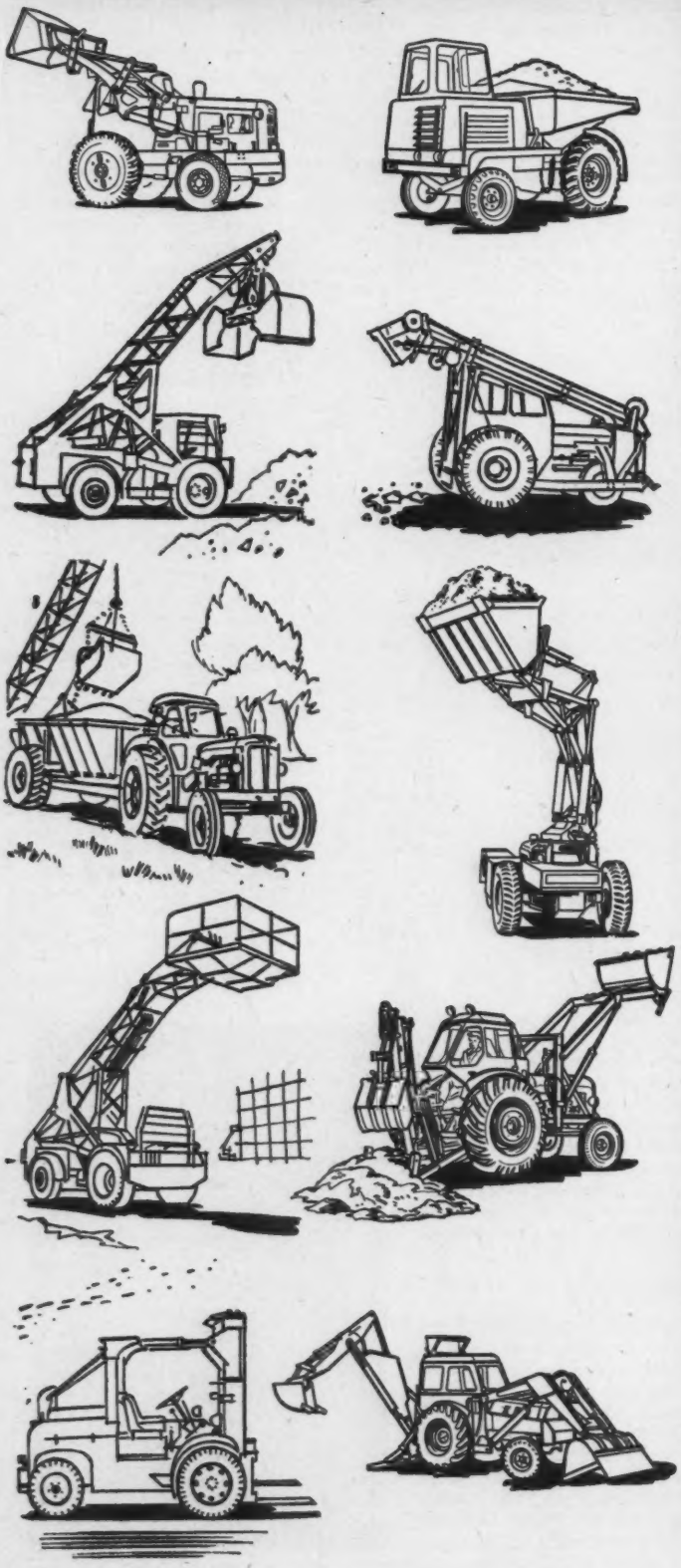
The L/X.5 infra-red dryer can be used for drying gum, latex, varnish, silk-screen inks, textiles, vitreous enamel frit, alkyd and other enamels, print on polythene and polystyrene, etc. It is said to be suitable for drying almost any flat or mainly flat article which has been coated or printed by any means. Other models are available for shaped articles.

The term infra-red relates to radiant heat applied at the most efficient wavelength, thereby ensuring maximum penetration. By use of this machine, drying times are claimed to be reduced from several hours to a few minutes, and often to seconds.

The heat is supplied by five projector units. Articles to be dried are carried under these units on a 13-ft. conveyor, which feeds them into a hopper at the end of the machine. The speed of the conveyor is variable, and five widths of conveyor are available. The machine is fitted with castors to enable easy movement. George Vokes (Infra Red) Ltd., Infra Red Works, High Road, New Southgate, London, N.11.

EMD 6007 for further information

EXPERIENCED OPERATORS INSIST ON



FORDSON POWER

Men who have kept to the tightest schedules in the toughest conditions; men who have manned machines working round the clock, seven days a week; these are the men who know from experience that for proved reliability Fordson Power is unequalled. Add to reliability all the other Fordson advantages of high output, low costs, unrivalled service and spare parts organisation, and almost unlimited choice of build-ups in the 30-40 and 40-50 b.h.p. classes. That's why more Fordson power units than any other are used in industrial equipment. Write for detailed specifications.

WISE BUYERS INSIST ON FORDSON POWER

INDUSTRIAL SALES DEPARTMENT · TRACTOR DIVISION
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WHAT'S NEW IN THE OFFICE

High-speed Copies of Oscillograph Records

A new way of copying oscillograph records quickly and economically is now offered. This service uses the Copyflo continuous printer to copy oscillograph records by automatic xerography (dry, electrical photography) at a speed of 20 ft./min.

The copy is permanent, black-on-white, and said to be sharper and more easy to read than the photographic print. As the copy is on ordinary paper it is lighter and less bulky, and can therefore be mailed more cheaply and easily.

By using a special feed device, two or more oscillograph records can be copied side by side. Model 12A, used by the Copy Service, has a printing spread of 11 in. on 13-in. paper. Rank-XeroX Copy Service, 40 Wilson Street, London, E.C.2.

EMD 6008 for further information

Lettering Instrument for Draughtsmen

Lettering on drawings, and for various kinds of display work, is said to be simplified and speeded up by the Varigraph lettering instrument. Instead of conventional stencils, this unit uses a pantograph principle; the master letters on an engraved metal template are traced out with a stylus, and this controls the movement of the pen through a mechanism which allows the size of lettering to be greater or less than that of the template.

The degree of enlargement or reduction is set independently for the vertical and horizontal directions; as a result, tall thin letters or elongated squat letters can be produced from the same template. The mechanism is precision made, and controls are provided by which the height and width of the letters produced from the standard template can be adjusted and read off directly in thousandths of an inch. Templates carrying alphabets in different styles of lettering are interchangeable. General Trade Equipment Ltd., 82-90 Seymour Place, London, W.1.

EMD 6009 for further information

Complex-number Slide Rule

As is well known, the conventional slide rule multiplies and divides real numbers by adding or subtracting the logarithms of the numbers engraved along a line. The same principle has now been extended to include complex numbers, by engraving the complex logarithms on the surface of a cylinder. The numbers are multiplied or divided by a process of vector addition or subtraction performed by sliding and rotating the cylinder.

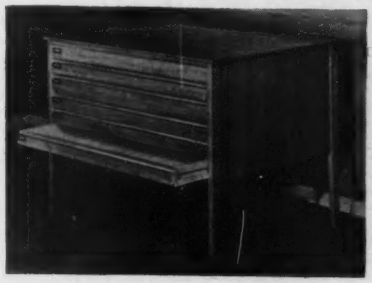
The numbers may be expressed in either rectangular or polar co-ordinates; the result is indicated in both rectangular and polar form. This new slide rule also provides a ready means of converting a number from one form to the other. It can be used to multiply or divide complex numbers with the same facility and accuracy as a conventional slide rule is used to multiply or divide real numbers. W. F. Stanley & Co. Ltd., Avery Hill Road, New Eltham, London, S.E.9.

EMD 6010 for further information

Plan File Cabinet

A new plan file cabinet of a simple and neat design has been added to the CC range of office furniture. There are three versions—with three, six or nine drawers, all in double elephant size. The drawers have louvred recessed mouldings which act as finger grips. All three units are 4 ft. long by 3 ft. wide by 3 ft. high, and finished in oak or mahogany. Carson Bros. (Productions) Ltd., Desk House, Honywood Road, Basildon, Essex.

EMD 6011 for further information



New Publications and Technical Literature

The General Electric Co. Ltd.: Three illustrated leaflets: "Induction Heating Furnaces"; "High Temperature Furnaces (with Hydrogen Atmosphere, 1,200-2,500 deg. C.)"; "Roller Hearth Furnaces". Erith, Kent.

EMD 6012

The English Electric Co. Ltd.: "Weldability", a 56-page booklet designed to go in the welder's pocket. Liberally illustrated with cartoons and simple diagrams, it is full of tips for better welding. Welding Division, East Lancashire Road, Liverpool, 10.

EMD 6013

B.E.N. Patents Ltd.: Leaflet CB.193, entitled "Air Compressors for Industry"; and leaflet CB.195, called "Portable Air Compressors" — both well illustrated. High Wycombe, Bucks.

EMD 6014

Federation of British Rubber and Allied Manufacturers: "Guide to the Drafting of Specifications for Rubber Products", leaflet No. FSAC/56. 43 Bedford Square, London, W.C.1.

EMD 6015

The Morgan Crucible Co. Ltd.: "Products of Morgans (KJ.83)", a booklet of illustrations, with captions in five languages. Battersea Church Road, London, S.W.11.

EMD 6016

Wilmot Breeden Ltd.: 13-page brochure on the Velflo circular duct fittings. Goodman Street, Birmingham, 1.

EMD 6017

The Aluminium Development Association: 56-page well-illustrated booklet describing aluminium corrugated and troughed sheeting for roofing and vertical cladding. 33 Grosvenor Street, London, W.1.

EMD 6018

Imperial Chemical Industries Ltd.: 16-page booklet of information on I.C.I. wrought zironcium products. Metals Division, P.O. Box 19, Templar House, 81-87 High Holborn, London, W.C.1.

EMD 6019

Hydraulics & Pneumatics Ltd.: 30-page brochure, published as an aid to the non-technical branches of industrial administration, describing the various types of fluid power equipment available, with descriptions of proven hydraulic and pneumatic circuits. Wulfruna Works, Villiers Street, Wolverhampton.

EMD 6020

A. & C. Jenner Ltd.: 24-page well-illustrated catalogue of the firm's mechanical handling equipment. Clarendon Works, Mitcham, Surrey.

EMD 6021

The Suffolk Iron Foundry (1920) Ltd: "Quick reference welding chart No. 2", giving conversion factors and tables, temperature scales, flame temperatures, gas values, melting points and welding data for Sifbronze welding on mild steel and mild steel fusion welding. Common defects in welding and forms of welding joints are also illustrated. Stowmarket, Suffolk.

EMD 6022

Turner Brothers Asbestos Co. Ltd.: Two new sample and specification booklets for Duraglas glass-fibre reinforcements, one for the standard range of woven glass roving, and the other for standard glass cloth. The booklets contain actual samples of the material, each sample being held in a card frame which can be removed for inspection. P.O. Box 40, Rochdale, Lancs.

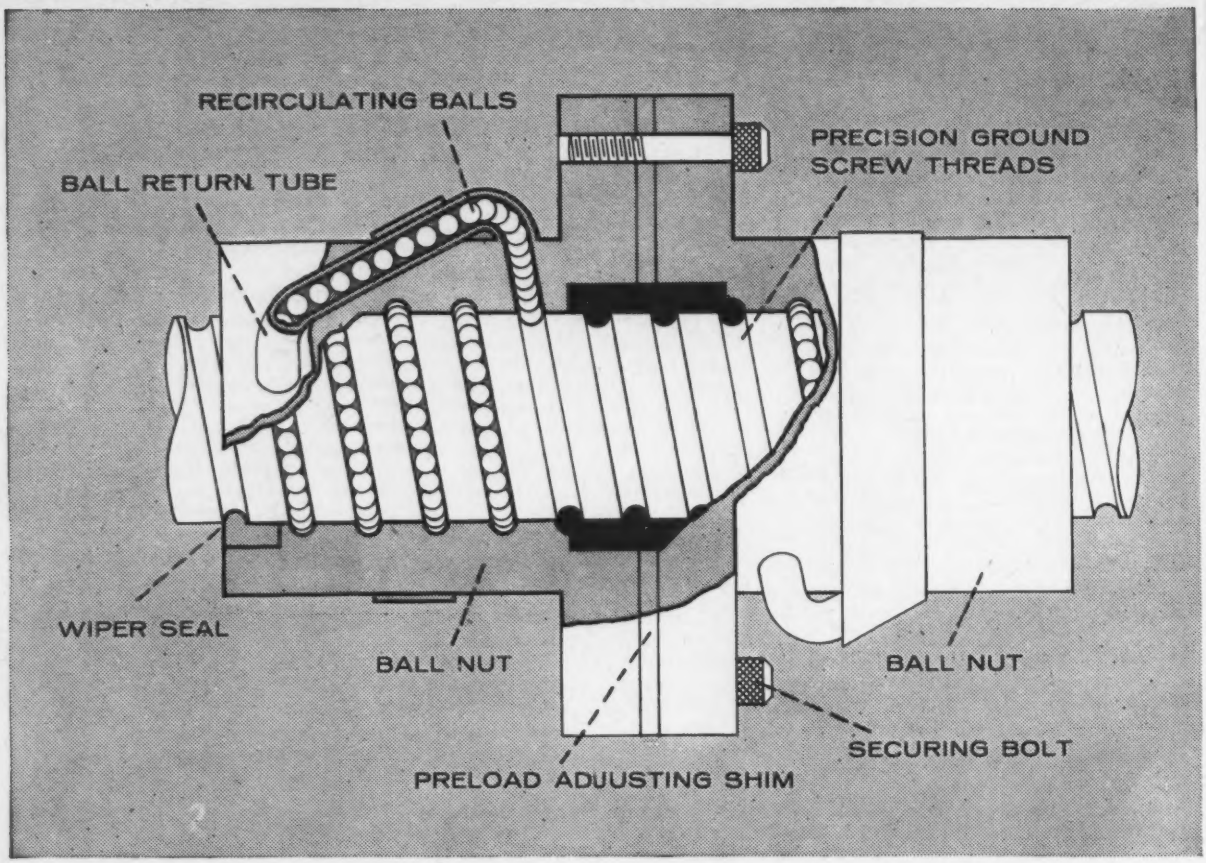
EMD 6023

Richard Klinger Ltd.: Large catalogue of the firm's jointings, packings, cocks, level indicators and valves, attractively set out and illustrated. Klingerit Works, Sidcup, Kent.

EMD 6024

Rank-XeroX Ltd.: A 4-page illustrated leaflet (R.X.57) explaining a new unitised microfilm system for the reproduction of engineering drawings. 33-41 Mortimer Street, London, W.1.

EMD 6025



Beaver pre-loaded ball screws, up to 95% efficient, operate at—52°C to over 400°C with no backlash

Bristol Siddeley Engines Limited produce Beaver* pre-loaded ball screws. These ball screws achieve a minimum efficiency of 90% and they can operate within a temperature range of—52°C to 400°C without lubrication, and up to 170°C when lubricated.

Machined and ground to the highest standards of precision engineering Beaver pre-loaded ball screws greatly increase transmission efficiency. They reduce the power required for actuation by as much as 80%, when converting rotary drive into linear output or force input into torque output. By eliminating backlash, with pre-loading, they give precise control over very small increments of motion and a high response frequency. And when compared to conventional screw mechanisms, they provide a predictable operating life which is much longer, require much less maintenance and give more trouble-free operation.

Basic design application analysis

Bristol Siddeley engineers make an exhaustive analysis of each specification. And each unit is specially designed for its particular application. Beaver ball screws are made automatically reversible or with controlled "no-back," with multiple or single circuits. Beaver pre-loaded ball screws have been proved as the most efficient method of converting rotary into linear thrust in over 2,700 engineering applications in many branches of industry. They have been designed already with rated operating load capacities of 370,000 lb (825,000 lb maximum static load) but the maximum potential operating load is, in most cases, limited only by the requirement.

Bristol Siddeley Beaver ball splines have been developed to eliminate the disadvantages of conventional splines. The designs are very effective in minimising friction, particularly when high torsional and bending loads are imposed during linear movement.

**Complete technical and manufacturing co-operation with Beaver Precision Products Inc, Detroit.*

For further information please write to J. B. Starky, Sales Manager (Ball Screws and Splines), Bristol Siddeley Engines Limited, PO Box 17, Coventry, England.

BRISTOL SIDDELEY ENGINES LIMITED

News of Industry

Philips Electrical Ltd. have given an important lead to the radio and television industry by issuing, to all main technical colleges throughout Britain, service manuals covering the company's current radio and television range. The offer was made direct to the Ministry of Education, and colleges receiving the manuals are being asked to treat the information being made available as confidential, and to use it only for academic purposes.

At the recent Sheffield Industrial Exhibition, the Gas Atmospheres Division of the **Incandescent Heat Co. Ltd.**, Smethwick, announced a new process for the low-cost production of nitrogen-hydrogen mixtures from blast furnace gas. Hynitrogen (sometimes termed HNX), consisting of nitrogen with 1-7 per cent hydrogen, is finding increasing use in the heat-treatment of steel strip and sheet, and provides an inert atmosphere for bright annealing. The demand for this type of atmosphere has led the Gas Atmospheres Division to develop a process with very low operating costs; the basic utilities cost less than 1s per 1,000 standard cu. ft. of prepared atmosphere. Basic designs now available cover 10,000, 25,000, 50,000 and 100,000 s. cu. ft./hr. units, but schemes can be prepared for any size of installation.

An order for a new high vacuum brazing furnace has been placed with **Vacuum Research (Cambridge) Ltd.** by the Admiralty. The new unit is to be of the electric resistance type evacuated to less than 0·0001 mm. mercury, with which a temperature of 1,300 deg. C. can be maintained in a zone 2 ft. long by 1 ft. square. A shielded window is provided to enable the operator to view specimens within the furnace, and three flexible thermocouples may be taken to any section of the hot zone. Two further thermocouples indicate the temperature of the heaters. A continuous record of pressure and temperature is provided by a six-point recorder, and all the furnace controls are power operated and interlocked against failure of mains services.

Polypenco Ltd., of Welwyn Garden City, have announced substantial price reductions in their range of Fluorosint shapes. Large quantity production of small electrical and chemical component parts can now be economically made to close tolerances by techniques similar to those employed in the field of powder metallurgy. New equipment has recently been installed at the firm's Welwyn Garden City factory for mass production by this method. Although the present size range of pressed parts is limited to 0·75 sq. in. cross-sectional area by ¼ in. length, this will be increased by the addition of further equipment as demand increases. (Examples from the Fluorosint range are shown in the accompanying illustration.)

Thomas Ashworth & Co. Ltd., Burnley, recently inaugurated a new factory for diecasting. Pressure and gravity diecastings in zinc and aluminium are made for many diverse industries, and range in weight from fractions of an ounce to 50 lb. Details are given in their booklet "Problems in Metal", which may be obtained on request. An advisory service is available.

Firth-Vickers Ltd., of Sheffield, have announced that Mr. W. H. Wentworth-Ping has been appointed special director in charge of all sales and sales promotion.

MEETINGS AND EXHIBITIONS

BX Plastics Ltd. will hold a two-day Plastics Exhibition and Symposium at the Grand Hotel, Sheffield, on February 21 and 22, 1961. A programme of papers on packaging, design trends and technical and other uses of plastics will be presented, against the background of an exhibition of plastics materials and their products. There will be three sessions a day, commencing at 10.30 a.m., 2.15 p.m. and 6 p.m. respectively. Free admission tickets are now available from: Publicity Dept., BX Plastics Ltd., London, E.4.

A one-day Symposium on Lubrication Engineering is being arranged by the **Institution of Plant Engineers**, on March 23, 1961, at the Institution of Mechanical Engineers, London. It will be open to non-members, and will consist of four papers with discussion periods. The papers will be: "Lubrication Engineering and the Petroleum Industry"; "Lubrication Engineering and the Chemical Industry"; Lubrication Engineering and the Plant Manufacturer"; and "Lubrication Engineering in the Steel Industry". The Symposium fee, including one set of preprints, morning coffee and afternoon tea, will be 30s.

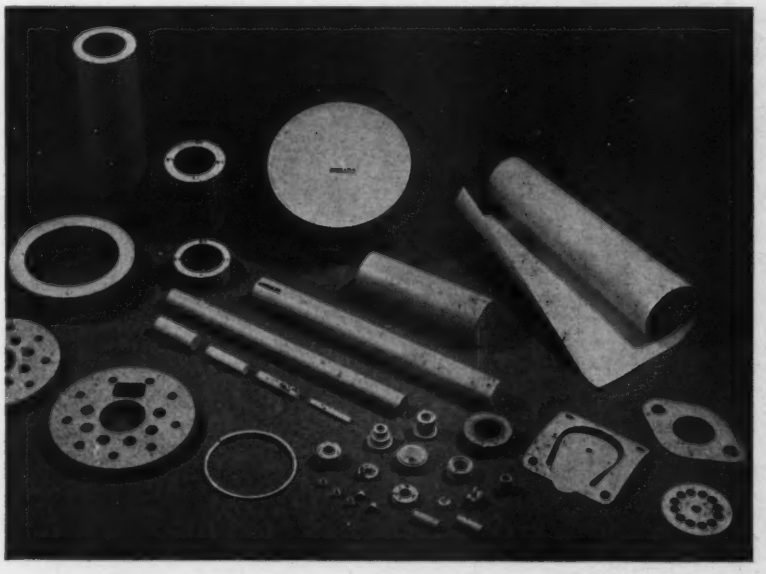
FILMS

Mobil Oil Co. have produced a new film entitled *The Answer is Simple*, intended for motor transport operators and civil engineering contractors. It is designed to show that, by using the Mobil Economy Service, all purchasing, storage and handling operations can be simplified and considerable savings made in time and money. This 18-min. technicolor film is available from Mobil's Industrial Divisional Offices in London, Birmingham, Sheffield, Manchester, Newcastle, Bristol, Cardiff, Glasgow, Plymouth, Belfast and Dublin.

Two new 16-mm. black-and-white sound films of interest to transport operators and vehicle owners have been released by **Perkins Engines Ltd.** One, named *The Six 354*, runs for 17 min., and tells the story of the development and production of Perkins' new 112-b.h.p. direct-injection transport diesel engine. The other, *Why the Diesel?—No. 1, The Vehicle Operator*, is a 10-min. film showing the advantages of diesel-engined vehicles. It describes the evolution of goods transport from man-power and horse-power to the modern high-powered diesel lorry. Both films are available on loan, free of charge.

An 18-min. film called *Spearhead of a Thunderbird* is available in 16-mm. colour prints. It shows the manufacture and testing of the plastics radome that forms the nose cone of the English Electric Thunderbird guided missile. Application for the loan of prints should be made to **Bakelite Ltd.** (Publicity Department).

Another film by the same firm is *Bambini*, which shows the building and completion of a motor scooter sidecar from polyester resin reinforced with glass material. It is available in 16-mm. colour prints, and has a running time of 18 min.



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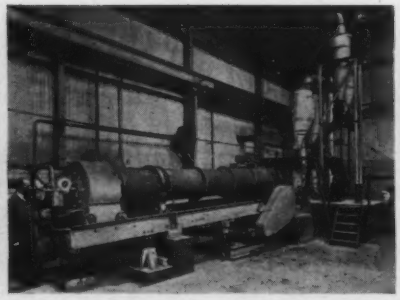

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